President Putin rewarding double-primary thermonuclear warhead designer Yuri Trutnev, November 17, 2017

Yuri Trutnev, *The creation of nuclear weapons is a special work*, RIA Novosti, 11/22/2017, https://ria.ru/20171122/1509304656.html

"But in the meantime, I already had another idea in my head - a more advanced product based on a new principle for designing a thermonuclear charge. After testing the RDS-37, the next day in the evening I called my friena and colleague Yuri Nikolaevich Babaev to the bank of the Irtysh and said: "Yura, let's try to do just such a thing." And he agreed. We returned to Sarov and drew a charge diagram and proposed it. This product received an index of 49. ... Zeldovich had three failures of thermonuclear units during tests in a row! ... The test of product 49 took place on the Day of the Soviet Army, February 23, 1958 at the test site on Novaya Zemlya. The success was very big."

Warhead for the first multiple reentry vehicle of a sea-launched ballistic missile. As part of the product, a small-sized thermonuclear charge and devices of the automation system, which have minimal dimensions, are used. Among the developers, the project was called "One Hundred per Hundred" (to accommodate 100 kilotons of power in 100 kg of charge). The dense layout of the components of the warhead made it possible to create a light and small-sized product that meets the requirements for placing three warheads on one launch vehicle. The mass of the warhead is 170 kg; the 1 kt/kg objective suggests it has a yield of 170 kt if design yield was achieved. The product was put into service in 1974.

The first warhead of a multiple reentry vehicle with individual aiming at aiming points, weight 210 kg. The product was put intc service in 1978. Again, the 1 kt/kg objective suggests 210 kt.

SLBM non-MIRV, weight 650 kg, 1 Mt. Put in service in 1974.

These examples suggest that dual linear imploded primary devices gave 1 kt/kg; dual spherical primaries gave 1.5 kt/kg.

VNIITF RUSSIAN NUCLEAR WEAPONS SUMMARY FILM


Ядерные
боеприпасы
сухопутных
войск
(NUCLEAR AMMUNITION OVERLAND TROOPS)


(PRODUCT 269)
изделие 269


(152.4 mm diameter
nuclear artillery shell)
изделие 152
(PRODUCT 152)


Научный руководитель
института
Е.И. Забабахин
Главный конструктор
института по первому
конструкторскому
направлению
Б.В. Литвинов
Главный конструктор
института по второму
конструкторскому
напрвлению
О.Н. Тиханэ

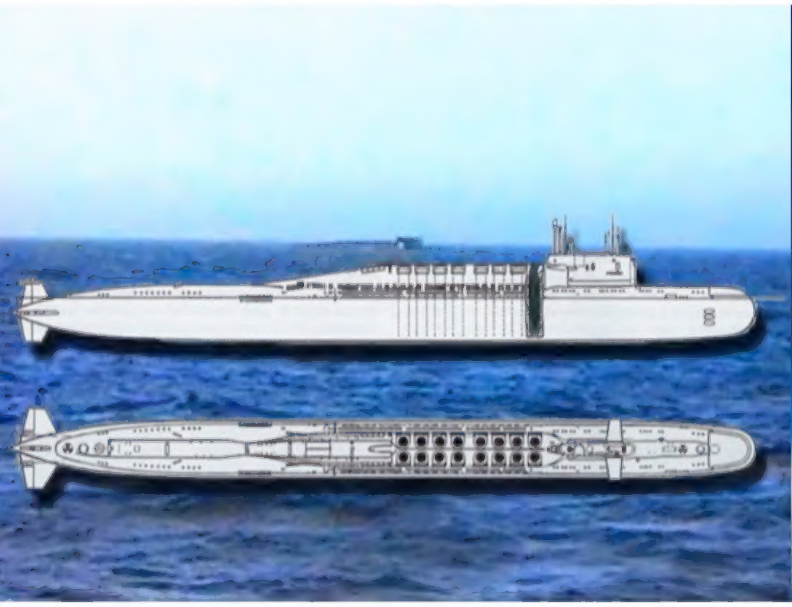

(PRODUCT 6: NUCLEAR WARHEAD FOR
SURFACE-TO-AIR DEFENCE MISSILES)
изделие 6

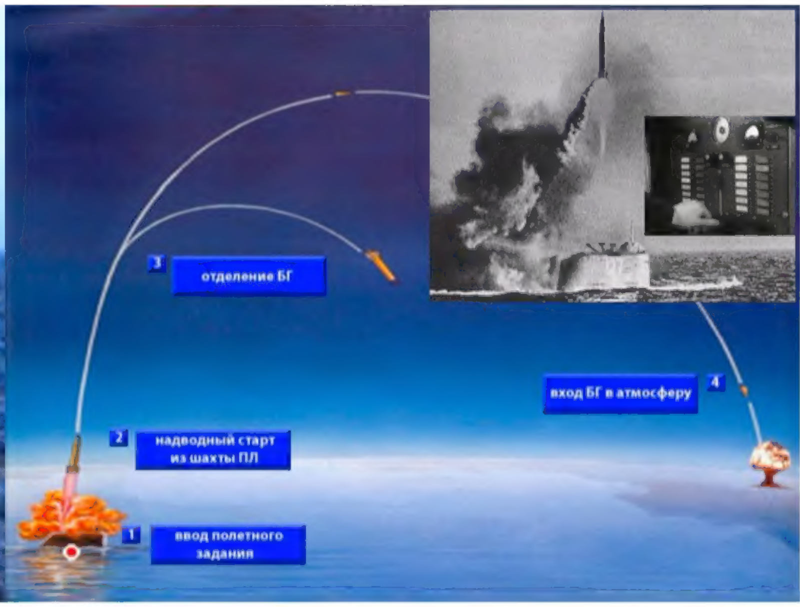

(PRODUCT 245: LARGE, HIGH YIELD THERMONUCLEAR FREEFALL BOMB)
изделие 245

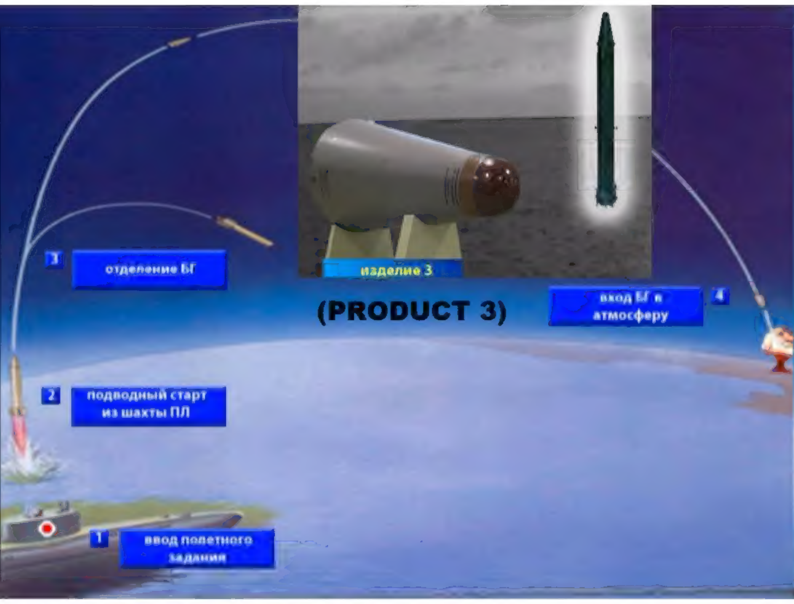

(PRODUCT 30: HIGH YIELD NUCLEAR WARHEAD FOR ARMY TACTICAL MISSILES)
изделие 30


(STRATEGIC NUCLEAR MISSILES OF THE NAVY)
Ядерное
боевое оснащение
ракетных комплексов
стратегического назначения
ВМФ


изделие 255А13

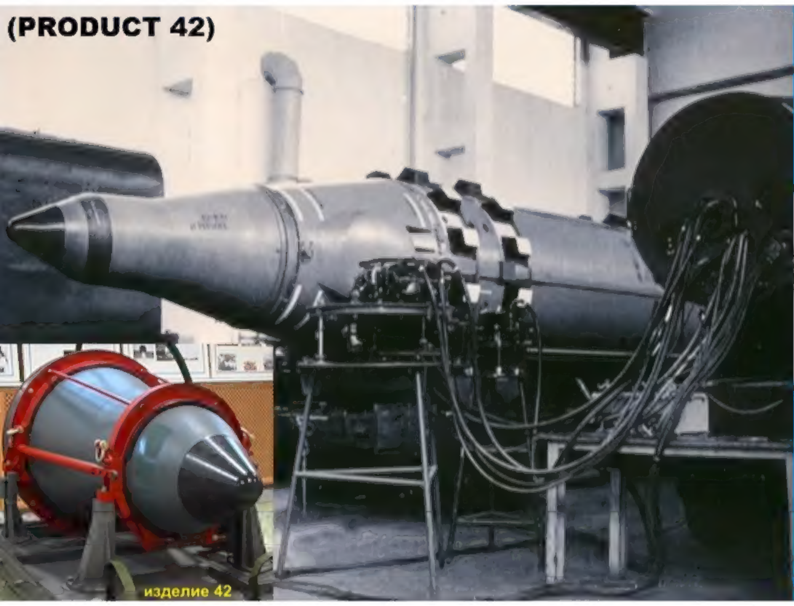



3 отделение БГ
4 вход БГ в атмосферу
2 надводный старт из шахты ПЛ
1 ввод полетного задания

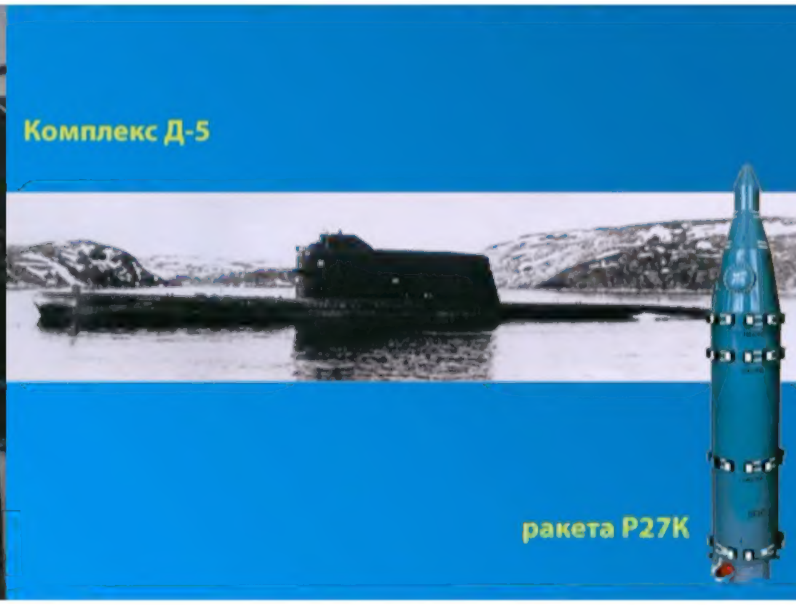


изделие 3
(PRODUCT 3)
3 отделение БГ
4 вход БГ в атмосферу
2 подводный старт из шахты ПЛ
1 ввод полетного задания

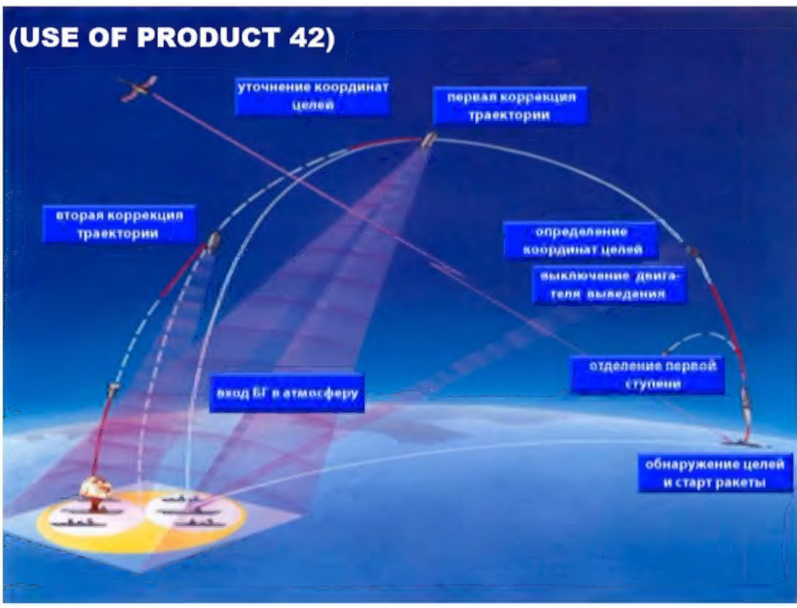
3 отделение БГ
изделие 15
4 вход БГ в атмосферу
2 старт ракеты
1 ввод полетного задания
Комплекс Д-5
ракета Р27



(PRODUCT 42)
изделие 42

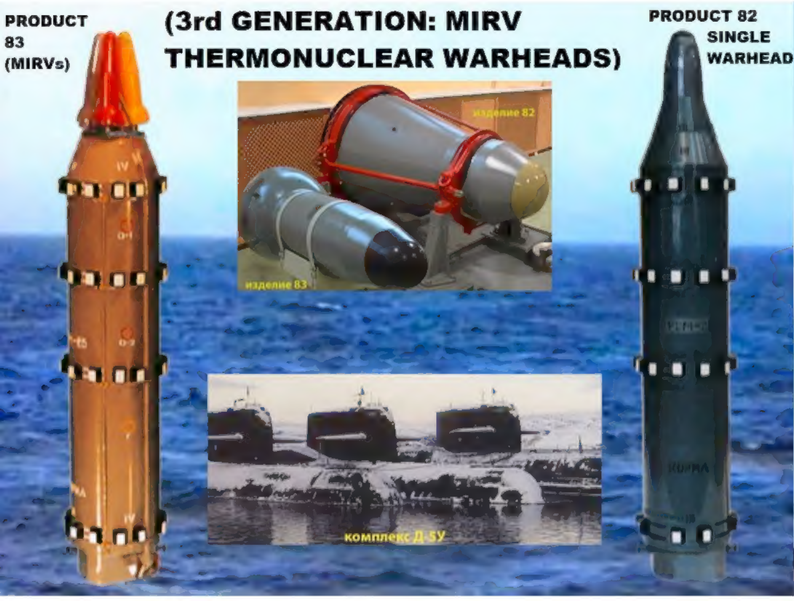


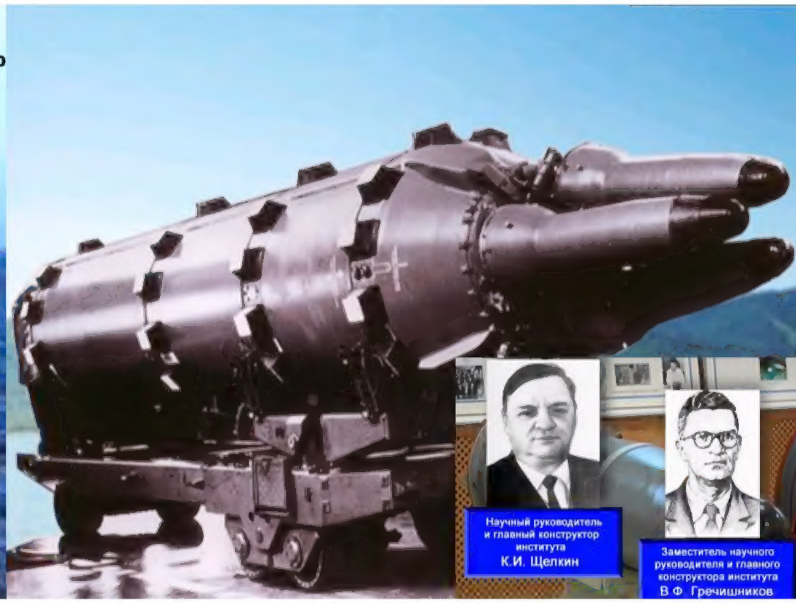
Комплекс Д-5
ракета Р27К

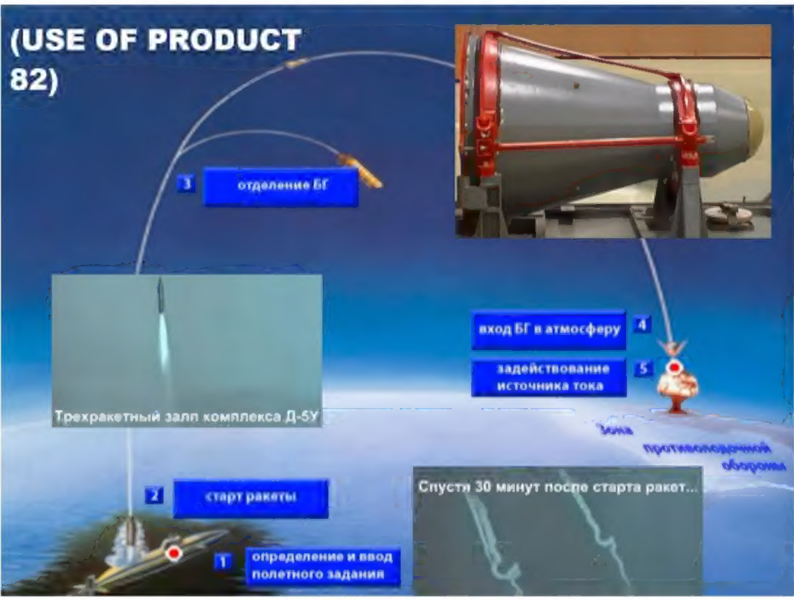


(USE OF PRODUCT 42)
уточнение координат целей
первая коррекция траектории
вторая коррекция траектории
определение координат целей
выключение двигателя выведения
отделение первой ступени
вход БГ в атмосферу
обнаружение целей и старт ракеты

(USE OF PRODUCT 46)
отделение БГ
изделие 46
отделение головной части
(INTERIOR OF WARHEAD)
(ARMING, FUSING, FIRING SYSTEM)
NUCLEAR DEVICE
(PRODUCT 46 IN MISSILE)
коррекция траектории на второй ступени
сеанс астронавигации на второй ступени
Комплекс Д-9
ракета Р29
вход БГ в атмосферу


PRODUCT 83 (MIRVs)
(3rd GENERATION: MIRV THERMONUCLEAR WARHEADS)
PRODUCT 82 SINGLE WARHEAD
изделие 82
изделие 83
комплекс Д-5У

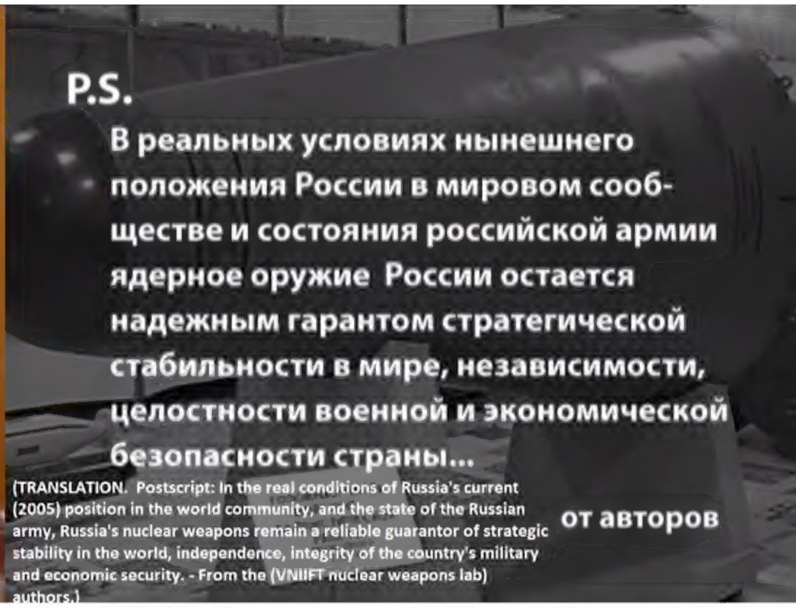

Научный руководитель и главный конструктор института К.И. Щелкин
Заместитель научного руководителя и главного конструктора института В.Ф. Гречишников


(USE OF PRODUCT 82)
3 отделение БГ
Трехракетный залп комплекса Д-5У
4 вход БГ в атмосферу
5 задействование источника тока
зона противолодочной обороны
2 старт ракеты
1 определение и ввод полетного задания
Спусти 30 минут после старта ракет...


3 поколение
изделие 95
изделие 94


DESIGNERS OF PRODUCT 95
Died '58 after double primary H-bomb test of 23 Feb. 1958. => Mirv uses a double primary.
Научный руководитель и главный конструктор института К.И. Щелкин
Заместитель научного руководителя и главного конструктора института В.Ф. Гречишников


USE OF PRODUCT 95
3 поколение
3 MIRVs FROM SINGLE MISSILE
5 прицельное разделение БГ
4 ввод полетного задания
3 отделение второй ступени
2 сеанс астронавигации
вход БГ в атмосферу 6
1 отделение первой ступени



Министерство Российской Федерации по делам гражданской обороны, чрезвычайным ситуациям и ликвидации последствий стихийных бедствий

ГРАЖДАНСКАЯ ОБОРОНА

Учебник

2014 г.

Защитными свойствами от действия ударной волны обладают также танки, БТР и БМП.

При невозможности использовать защитные свойства различных сооружений следует применять элементарные меры защиты. Так как для незащищенного человека наибольшую опасность представляет скоростной напор, то целесообразно до подхода ударной волны лечь на землю лицом вниз, головой или ногами в сторону взрыва. При этом площадь поперечного сечения уменьшается примерно в 10 раз, а воздействие скоростного напора будет минимальным.

Воздействие скоростного напора снижают различные углубления (кюветы, ямы, воронки и др.) или невысокие прочные стенки, пни и другие предметы, за которыми можно укрыться.

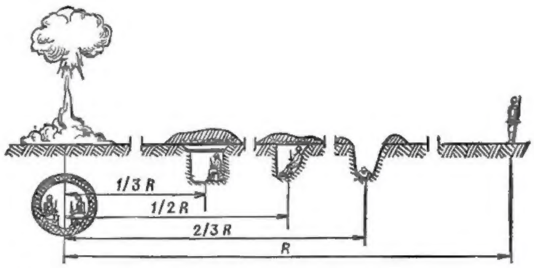


Рис. 1.8. Защитные свойства полевых фортификационных сооружений от воздушной ударной волны ядерного взрыва

Ministry of the Russian Federation for Civil Defense, Emergencies and Elimination of Consequences of Natural Disasters

CIVIL DEFENSE

Textbook

2014 г.

Tanks, armored personnel carriers also have protective properties against the action of a shock wave and BMP.

If it is impossible to use the protective properties of various structures , elementary protective measures should be applied. Since high-speed pressure is the greatest danger for an unprotected person, it is advisable to lie on the ground face down, head or feet in the direction of the explosion before the shock wave approaches. At the same time, the cross-sectional area is reduced by about 10 times, and the impact of the high-speed pressure will be minimal.

The impact of high-speed pressure is reduced by various depressions (ditches, pits, funnels, etc.) or low strong walls, stumps and other objects behind which you can hide.

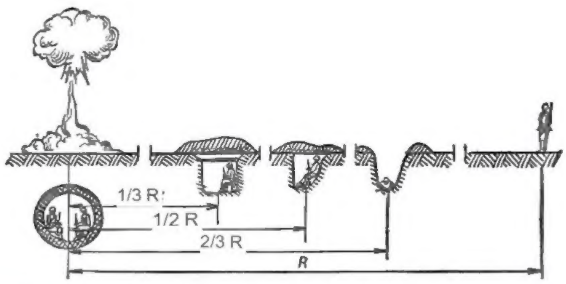
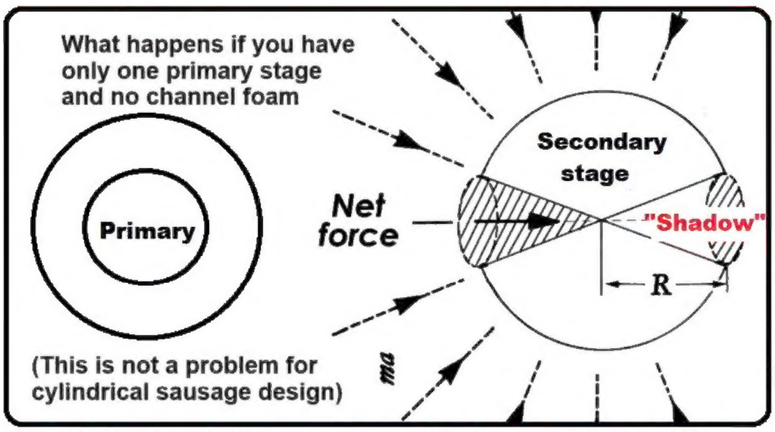


Figure 1.8. Protective properties of field fortifications from the air shock wave of a nuclear explosion

TRANSLATION FROM PUTIN'S 2014 CD BOOK

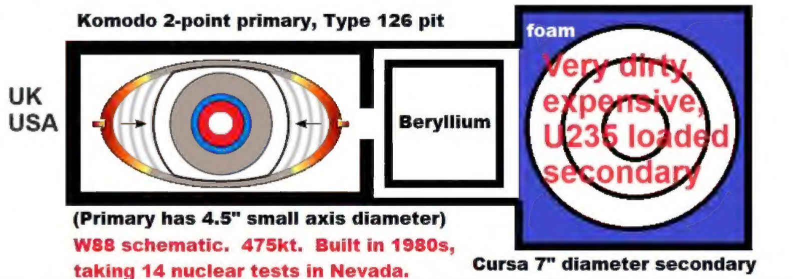
Difference in basic design of UK/USA versus Russian Mirv's

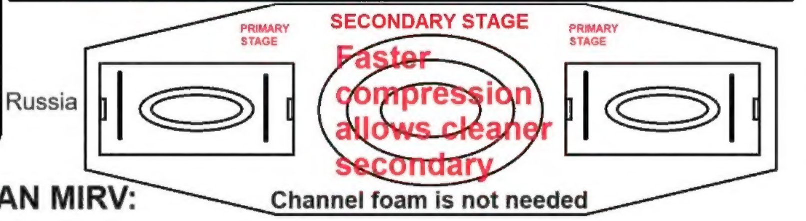
Anisotropic (unequal from all directions) x-rays on 2nd stage:



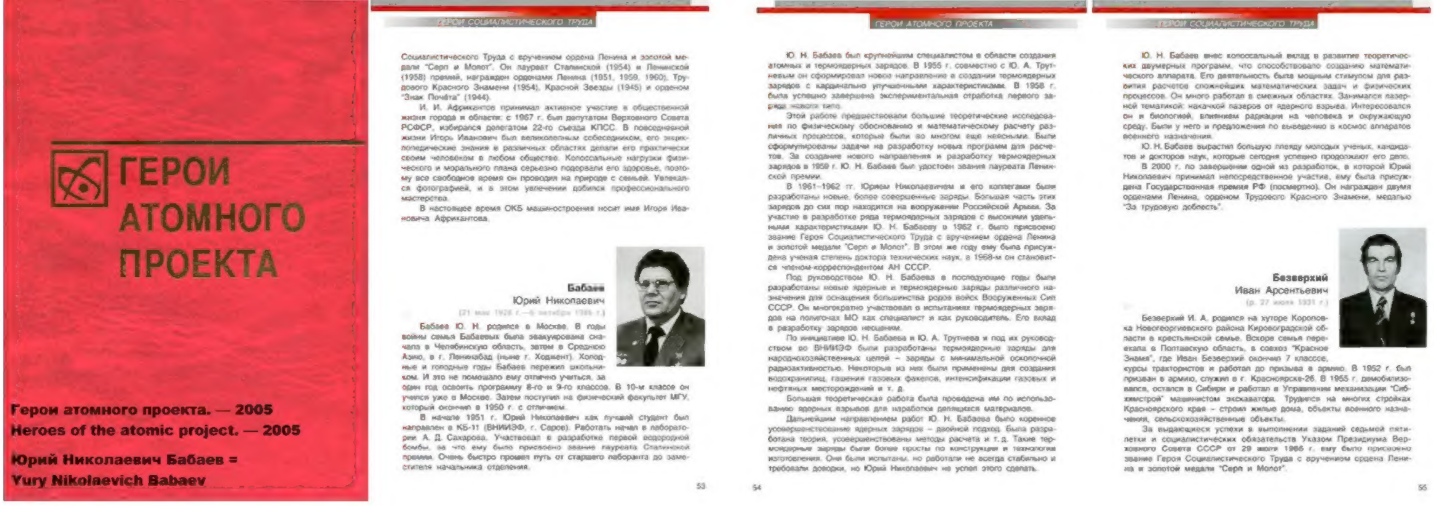
Second stage is not uniformly compressed due to x-ray shadow on side furthest from primary stage.

In USA and UK warheads, low density plastic foam is used to disperse x-ray energy into the shadows:





RUSSIAN MIRV:



23 Feb 1958: first test of double-primary design. Babaev, Russian book *Heroes of the atomic project*

Ю. Н. Бабаев был крупнейшим специалистом в области создания атомных и термоядерных зарядов. В 1955 г. совместно с Ю. А. Трутневым он сформировал новое направление в создании термоядерных зарядов с кардинально улучшенными характеристиками. В 1958 г. была успешно завершена экспериментальная отработка первого заряда нового типа.

Этой работе предшествовали большие теоретические исследования по физическому обоснованию и математическому расчету различных процессов, которые были во многом еще неясными. Были сформулированы задачи на разработку новых программ для расчетов. За создание нового направления и разработку термоядерных зарядов в 1959 г. Ю. Н. Бабаев был удостоен звания лауреата Ленинской премии.

В 1961–1962 гг. Юрием Николаевичем и его коллегами были разработаны новые, более совершенные заряды. Большая часть этих зарядов до сих пор находится на вооружении Российской Армии. За участие в разработке ряда термоядерных зарядов с высокими удельными характеристиками Ю. Н. Бабаеву в 1962 г. было присвоено звание Героя Социалистического Труда с вручением ордена Ленина и золотой медали "Серп и Молот". В этом же году ему была присуждена ученая степень доктора технических наук, а 1968-м он становится членом-корреспондентом АН СССР.

Под руководством Ю. Н. Бабаева в последующие годы были разработаны новые ядерные и термоядерные заряды различного назначения для оснащения большинства родов войск Вооруженных Сил СССР. Он многократно участвовал в испытаниях термоядерных зарядов на полигонах МО как специалист и как руководитель. Его вклад в разработку зарядов неоценим.

Yu. N. Babayev was the largest specialist in the field of creating atomic and thermonuclear charges. In 1955, together with Yu. A. Trutnev, he formed a new direction in the creation of thermonuclear charges with radically improved characteristics. In 1958, the experimental testing of the first row of a new type was successfully completed.

This work was preceded by extensive theoretical research on the physical justification and mathematical calculation of various processes, which were still largely unclear. Tasks for the development of new programs for calculations were formed. For the creation of a new direction and the development of thermonuclear charges in 1959, Yu. N. Babaev was awarded the title of Lenin Prize laureate.

B 1961-1962 Yuri Nikolaevich and his colleagues have developed new, more advanced charges. Most of these charges are still in service with the Russian Army. For his participation in the development of a number of thermonuclear charges with high specific characteristics, Yu. N. Babayev was awarded the title of Hero of Socialist Labor in 1962 with the award of the Order of Lenin and the gold medal "Sickle and Mopot". In the same year he was awarded the degree of Doctor of Technical Sciences, and in 1968 he became a corresponding member of the USSR Academy of Sciences.

Under the leadership of Yu. N. Babayev, new nuclear and thermonuclear charges of various values were developed in subsequent years to equip most branches of the Armed Forces of the USSR. He repeatedly participated in the tests of thermonuclear missiles at the landfills of the Ministry of Defense as a specialist and as a leader. His contribution to the development of charges is invaluable.

Translation from Russian to English

IN 2005, RUSSIA DECLASSIFIED DOUBLE-PRIMARY TECHNOLOGY FIRST TESTED 23 FEBRUARY 1958 AND STILL IN USE TODAY:

По инициативе Ю. Н. Бабаева и Ю. А. Трутнева и под их руководством во ВНИИЭФ были разработаны термоядерные заряды для народнохозяйственных целей – заряды с минимальной осколочной радиоактивностью. Некоторые из них были применены для создания водохранилищ, гашения газовых факелов, интенсификации газовых и нефтяных месторождений и т. д.

Большая теоретическая работа была проведена им по использованию ядерных взрывов для наработки делящихся материалов.

Дальнейшим направлением работ Ю. Н. Бабаева было коренное усовершенствование ядерных зарядов – двойной подход. Была разработана теория, усовершенствованы методы расчета и т. д. Такие термоядерные заряды были более просты по конструкции и технологии изготовления. Они были испытаны, но работали не всегда стабильно и требовали доводки, но Юрий Николаевич не успел этого сделать.

Ю. Н. Бабаев внес колоссальный вклад в развитие теоретических двумерных программ, что способствовало созданию математического аппарата. Его деятельность была мощным стимулом для развития расчетов сложнейших математических задач и физических процессов. Он много работал в смежных областях. Занимался лазерной тематикой: накачкой лазеров от ядерного взрыва. Интересовался он и биологией, влиянием радиации на человека и окружающую среду. Были у него и предложения по выведению в космос аппаратов военного назначения.

Ю. Н. Бабаев вырастил большую плеяду молодых ученых, кандидатов и докторов наук, которые сегодня успешно продолжают его дело.

В 2000 г. по завершении одной из разработок, в которой Юрий Николаевич принимал непосредственное участие, ему была присуждена Государственная премия РФ (посмертно). Он награжден двумя орденами Ленина, орденом Трудового Красного Знамени, медалью "За трудовую доблесть".

At the initiative of Yu. N. Babaev and Yu. A. Trutnev and under their leadership, thermonuclear charges for national economic chains were developed at VNIIEF - charges with minimal scoping radioactivity. Some of them were used to create reservoirs, extinguish gas flares, intensify gas and oil fields, etc.

A lot of theoretical work was carried out by him on the use of nuclear explosions for the development of fissile materials.

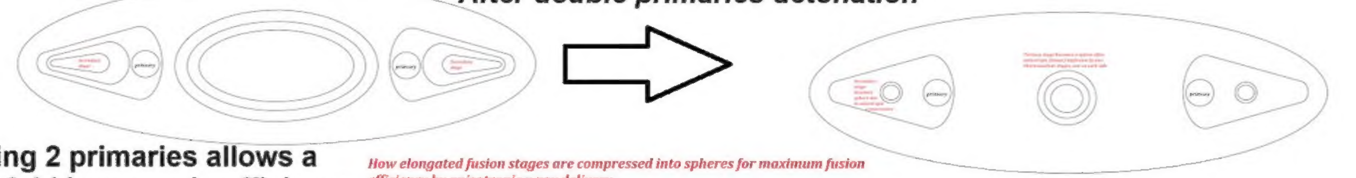
The further direction of Yu. N. Babayev's work was the radical improvement of nuclear charges - a dual approach. The theory was developed, calculation methods were improved, etc. Such thermonuclear charges were simpler in design and manufacturing technology. They were tested, but they did not always work stably and required fine-tuning, but Yuri Nikolaevich did not have time to do this.

Yu. N. Babaev made a copossal contribution to the development of theoretical deumeric programs, which contributed to the creation of a mathematical apparatus. His activity was a powerful incentive for the development of calculations of the most complex mathematical problems and physical processes. He worked a lot in related fields. He was engaged in laser subjects: pumping laser from a nuclear explosion. He was also interested in biology, the effect of radiation on humans and the environment. He also had proposals for launching military vehicles into space.

Yu. N. Babayev has raised a large galaxy of young scientists, candidates and doctors of sciences, who today successfully continue his work.

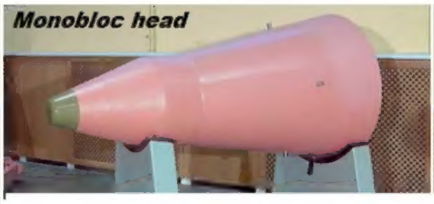
In 2000, upon completion of one of the developments in which Yuri Nikolayevich took a direct part, he was awarded the State Prize of the Russian Federation (posthumously). He was awarded two Orders of Lenin, the Order of the Red Banner of Labor, and the medal "For Labor Valor".

After double primaries detonation



Using 2 primaries allows a 2.5 fold increase in efficiency

How elongated fusion stages are compressed into spheres for maximum fusion efficiency by anisotropic x-ray delivery



Russian 370 kg thermonuclear warhead for missiles, put into service in 1978.

1st Russian MIRV for SLBM submarine missiles, put into service in 1974: mass is 170 kg, a small-sized thermonuclear charge allows placing three warheads on one launch vehicle

Monoblock head: 406 kg, entered service in 1974.

1st ever Russian MIRV warhead,210 kg each; first put into service in 1978.

Monoblock warhead of the first megaton range missile for submarines, 650 kg, year 1974

Monoblock warhead for use against ships and shore bases, 690 kg, 1975

650 kg 1968 SLBM warhead

40 kt tactical nuclear warhead, 1960: length 287 cm, midsection diameter 88 cm, mass 950 kg (Much heavier than American designs for such a low yield!)

1962: first mass-produced Russian aircraft dropped megaton yield strategic thermonuclear weapon

RIGHT: 1961 Russian megaton ICBM warhead Length 189.3 cm, midsection diameter 130 cm, mass 736 kg

1963 deployed Russian megaton SLBM warhead, length 230 cm , diameter 130.4 cm. Mass 1144 kg.

Russian 50 megaton bomb, 30 tons, 2x8m size, tested at half power on December 24, 1962, Novaya Zemlya.

200 kt thermonuclear warhead deployed from 1981 to 1991 for a 450 km range operational-tactical missile which was withdrawn from service under the INF Treaty, in exchange for the American Pershing INF disarmament.

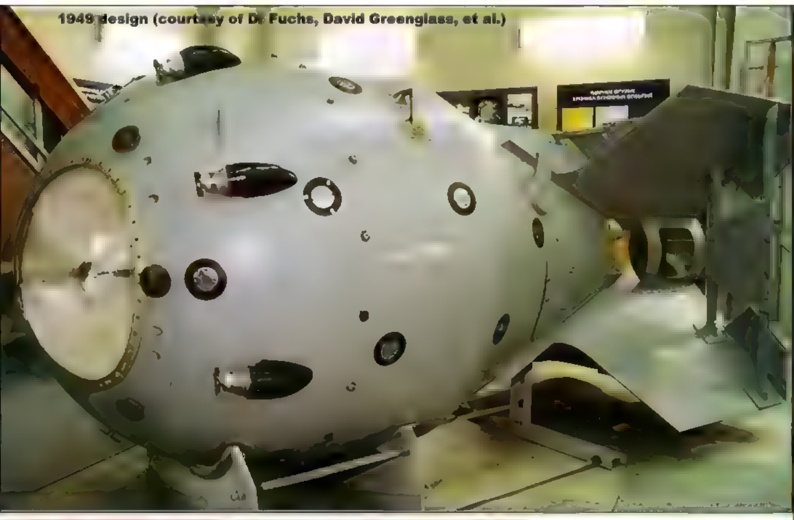
First ever Russian thermonuclear warhead for an intercontinental ballistic missile, 3 megatons yield, 8500 km range, in operation 1960 to 1966.

First ever Russian 40 kt nuclear warhead for an intermediate-range ballistic missile, 1200 km range, withdrawn from service 1960.

2 megaton warhead for ICBMs, range 12,000 km, 1970 to 1979.

Declassified Russian nuclear weapons film showing each nuclar warhead and how it is employed with specific missile delivery systems to deter the West from coercion.

1949 design (courtesy of Dr Fuchs, David Greenglass, et al.)

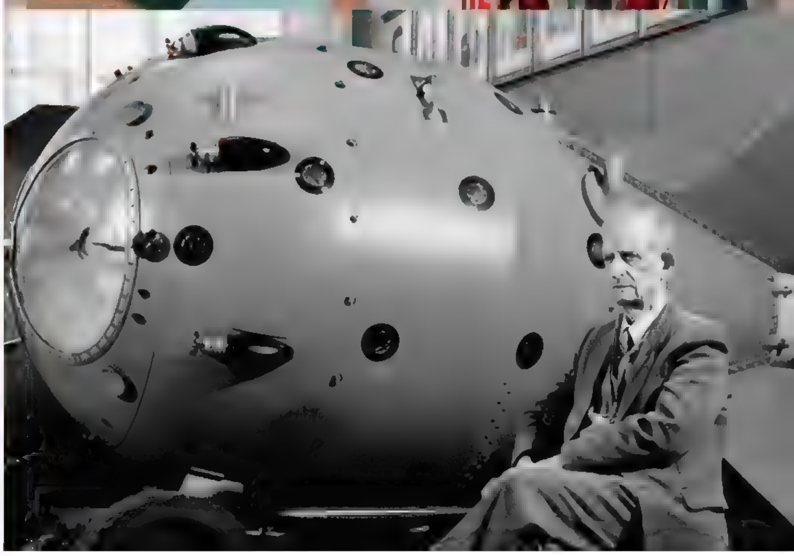


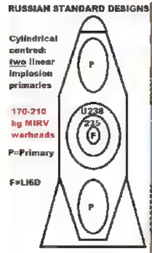
400 kt Alarm Clock 1953 H-bomb (Teller's 1947 design, an externally-boosted implosion bomb)

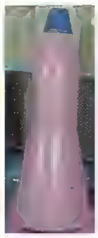
ABOVE: RDS1 tested 29 August 1949. Lower right shows designer Khariton at the museum with this copy

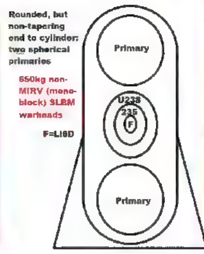
TSAR BOMBA: 100 mt (dirty U238 pusher on central secondary charge) or 50 mt (lead pusher)

Russian 1st serial nuclear warhead









№ 183

Препроводительная записка Е.П. Славского в Президиум ЦК КПСС с представлением сообщения по результатам испытания изделия РДС-37

Secret 24 Nov. 1955 report by E. P. Slavsky to the Presidium of the CCCP on results of 1.6Mt RDS-37 test

24 ноября 1955 г
Сов. секретно
(Особой важности)

В Президиум ЦК КПСС

Представляю подробное сообщение т. Завенягина и других по результатам испытания изделия РДС-37, полученное 23 ноября 1955 года.

Приложение: рукописный материал уб. ст. 119 оп на 4 листах.

п/п Е. Славский

24 ноября 1955 г
исх. ст. 398/1

Верно:[1]

[Приложение]

В Президиум ЦК КПСС

22 ноября 1955 г. в 9 часов 47 минут по местному времени на полигоне № 2 Министерства обороны СССР произведено испытание экспериментальной водородной бомбы новой конструкции — РДС-37.

Испытание производилось путем сбрасывания бомбы с самолета Ту-16 с высоты 12 тыс. метров.

Бомба сбрасывалась с парашютом, что дало возможность увеличить время ее падения с 56 до 7.. секунды и уйти самолету на безопасное расстояние.

В день испытаний была облачная погода, высота нижней кромки облаков была более двух километров.

Взрыв произошел на высоте 1 550 метров, и благодаря этому огненный шар хорошо наблюдался, пока не поднялся за облака.

Самолеты полностью разрушены на расстоянии до 5 000 метров, танки сильно повреждены на расстоянии до 2 000 метров, артиллерия получила полные разрушения на расстоянии до 3000 метров.

On 22 Nov. 1955 at 9.47am an RDS-37 was dropped by a Tu-16 flying at 12km altitude.

Parachute delivery gave time for the plane to escape to a safe distance before detonation.

Detonation occurred at 1.55km altitude. Severe damage occurred out to 5 km for planes, 2 km for tanks and 3 km for field artillery.

№ 190

Постановление СМ СССР № 46-1.сс о результатах испытания изделий РДС-27 и РДС-37, серийном производстве изделия РДС-27, разработке и изготовлении изделий на принципе атомного обжатия

5 Jan. 1956

г. Москва, Кремль

5 января 1956 г
Особой важности

USSR Council of Ministers on RDS27 &RDS37

Совет Министров СССР отмечает, что проведенное испытание изделия *РДС-27* и основанного на принципах АО изделия *РДС-37* дало положительные результаты и открывает возможности значительного увеличения мощности изделий при одновременном сокращении расхода *дефицитных* взрывчатых веществ.

Совет Министров СССР ПОСТАНОВЛЯЕТ:

1. Обязать Министерство среднего машиностроения:

а) приступить к изготовлению изделий, основанных на принципе АО, и изготовить в 1956 г. *10* изделий мощностью *1,7–1,9* млн т и *10* изделий мощностью *0,5* млн т. В 1956 г. подготовить производство на выпуск в течение 1956–1960 гг. в несколько раз больше мощных изделий, чем намечалось ранее;

Orders: 10 bombs of 1.7-1.9Mt yield and 10 bombs of 0.5 Mt yield stockpiled for 1956.

б) организовать в 1956 г. серийное изготовление изделий *РДС-27*;

Order: manufacture (serial production) RDS27

в) разработать и изготовить изделие на принципе АО мощностью *20–30* млн т весом *20–26* т и подготовить испытание его в *III* кв. 1956 г. на *Новой Земле* с самолета *М-4* с применением *парашюта*.

Order: make a 20-30 Mt bomb with a mass of 20-26 tons for air drop testing on Novaya Zemlya using an M-4 aircraft and a parachute.

№ 192

Записка А.Д. Сахарова, Я.Б. Зельдовича и В.А. Давиденко Н.И. Павлову с оценкой параметров изделий мощностью в 150 мегатонн и один миллиард тонн ТНТ

2 Feb. 1956 report by A.D. Sakharov, Ya. B. Zeldovich and V.A. Davidenko to N.I. Pavlov on 150 Mt and 1,000 Mt product designs

2 февраля 1956 г
Сов. секретно
(Особая папка)
Экз. № ..

Option 1:

Товарищу Павлову Н.И.

Сообщаем оценку параметров изделия мощностью в 150 *мегатонн ТНТ*

150Mt device using enriched lithium-6 fuel:

I вариант

Изделие с *дейтеридом лития* ( )%[ого обогащения, по-видимому, может быть сделано в следующих габаритах:

1) диаметр — *4* метра,
2) длина — *8–10* метров,
3) общий вес — около *100* тонн.

4 metres diameter
8-10 metres long
100 tons mass

Option 2 (natural lithium deuteride)

II вариант

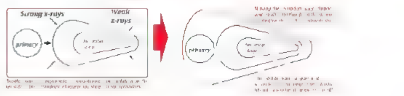
Изделие с уменьшенным расходом *лития-6* и с использованием природного *лития* может быть сделано в габаритах:

1) диаметр — 6–7 метров,
2) длина — 18–20 метров,
3) общий вес — около 500 тонн.

(Natural LiD containing 7.42% lithium-6)

Изделие мощностью в *один миллиард тонн ТНТ* может быть изготовлено по любому из этих двух вариантов при увеличении весов *дейтеридов* и природного *урана* в 6-7 раз, а весов делящихся материалов — приблизительно в 3 раза.

Natural LiD fuelled 150Mt bomb is 6-7m diameter, 18-20 m long, and 500 tons in mass. To increase the total yield from 150 Mt to 1000 Mt in either option 1 or option 2 (highly enriched Li-6 D or natural LiD containing 7.42% Li-6), simply increase the LiD and U in thermonuclear charge by factor of 6-7, and fissile mass by 3 times



Transportation of warhead bus to a Russian ICBM silo

МИНИСТЕРСТВО РОССИЙСКОЙ ФЕДЕРАЦИИ ПО АТОМНОЙ ЭНЕРГИИ

МИРНЫЕ ЯДЕРНЫЕ ВЗРЫВЫ

ISBN 5-86656-116-6

рия. Для этого на заводе Института была создана специальная физическая установка ФО-24, сконструированная группой специалистов первого конструкторского бюро ВНИИТФ под руководством Б. В. Литвинова и П.А. Есина. Физический опыт с использованием этой установки был проведен 04.02.1965 г. на Семипалатинском полигоне. В этом эксперименте, возможно, впервые в мире было осуществлено зажигание большой массы газообразного дейтерия [17].

Развивая идеи, реализованные при проведении этого опыта, Е.Н. Аврорин предложил в новой физической схеме заряда использовать газообразный дейтерий под большим давлением (повышенной плотности). Проверка этого конструкторского предложения, проведенная 13.02.1966 г. на Семипалатинском полигоне, была успешной и полностью подтвердила результаты физических расчетов. Зажигание было осуществлено от первичного узла, осколочная активность которого не превышала 6% от общего энерговыделения. Таким образом был доказан факт получения энерговыделения от больших количеств дейтерия. Этот важный научный и практический результат открывал путь к использованию в энергетике самого дешевого сырья - дейтерия. То, чего не удалось получить в дорогостоящих и сложнейших установках для термоядерного синтеза, было получено в несоизмеримо больших масштабах при подземном ядерном взрыве.

* *"Зажиганием" физики называют осуществление термоядерной реакции с заметным энерговыделением, которое способно привести к устойчивому течению термоядерных реакций.*

139

ABOVE: TRANSLATION FROM PAGE 139, DEUTERIUM BURNS AS PROVED IN A 6% FISSION (94% CLEAN) 125 KT 13 FEB. 1966 TEST!

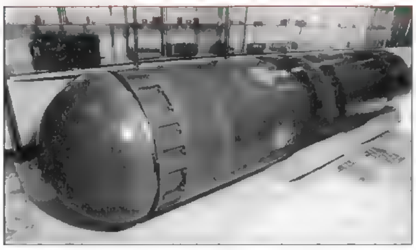


Рис. 3.2. Ядерное взрывное устройство большой мощности, предназначенное для проведения взрывов с выбросом грунта.

Испытания ядерных зарядов

RUSSIAN DEVELOPMENT OF CLEANER LOW YIELD TACTICAL NUCLEAR WEAPONS / PNEs

TEST № по каталогу	DATE Число, месяц, год	PLACE Место проведения испытаний	KILOTONS Энерговыделение, кт ТЭ	Примечание
245	13.02.1966	СИП шт.Е-1	125	Испытание заряда с термоядерным блоком, содержащим дейтерий под большим давлением
280	07.01.1968	СИП шт.810	7.5	Физический опыт для определения минимального количества дейтерия, которое может устойчиво взрываться.
294	09.11.1968	СИП шт.606	4	С 1967 по 1970 гг. испытывался заряд с термоядерным блоком, дающим минимум наведенной активности. Всего проведено 8 таких опытов.
296	18.12.1968	СИП шт.508	8.9	
299	13.04.1969	СИП шт.24П	0,001-20	
302	04.07.1969	СИП шт.710	15	
333	22.03.1971	СИП шт.510П	67	
357	28.03.1972	СИП шт.191	6	
377	10.12.1972	СИП скв.1204	140	Испытание особо "чистого" заряда с высоким коэффициентом термоядерности (около 1%)
382	23.07.1973	СИП скв.1066	212	
400	31.05.1974	СИП скв.1207	71	
422	08.06.1975	СИП шт.165	32	
616	18.08.1983	СИПНЗ шт.А-40	0,001-20	
658	28.12.1984	СИП скв.1353	0,001-20	

PURE DEUTERIUM GAS UNDER HIGH PRESSURE

TEST OF MINIMUM YIELD FOR PURE DEUTERIUM FUSION CHARGE BURN

EXAMPLES OF NUCLEAR TESTS FOR DEVELOPMENT OF LOW YIELD CLEAN CHARGE

140 KILOTON TOTAL YIELD CHARGE OF ONLY ~1% FISSION YIELD

Extracts from Beria's № 163 final (28 October 1949) report to Stalin the 1949 Russian nuclear test data

Заключительный доклад Л.П.Берия И.В.Сталину о результатах испытания атомной бомбы

28 октября 1949 г

Товарищу Сталину И.В

Оптическими измерениями (произведенными при помощи специально сконструированных сверхскоростных фотокамер, дающих 600 000, 100 000 и 25 000 кадров в секунду, обычных кино- и аэрофотокамер, специальных спектрографов и других измерительных приборов, заранее установленных на дистанциях 1 800, 3 000 и 5 000 метров от центра взрыва)

(= Russia set up high speed cameras running at 600,000, 100,000 and 25,000 frames/second at 1.8, 3.0 and 5.0 km from ground zero to film fireball.)

Измерено, что поток теплового излучения взрыва составляет 4 % энергии деления всей массы плутония, составлявшей заряд атомной бомбы, испытанной 29 августа 1949 года.

(= The bomb's measured thermal yield was 4%.)

Gamma doses (R) гамма-лучей		Neutron doses (R) нейтронного		Reflected blast, tons/m^2 Давление отраженной ударной волны	
300 м	420 000	300 м	27 000 000	200 м	2 900 т/$м^2$
400 м	155 000	400 м	38 000	250 м	1 560
500 м	68 000	500 м	12 000	300 м	770
600 м	32 000	600 м	4 200	400 м	225
700 м	15 000	700 м	1 800	500 м	82
800 м	7 800	800 м	800	600 м	48
900 м	4 200			800 м	21
1 000 м	2 300	1 000 м	180	1 200 м	12,1
1 100 м	1 260			1 800 м	6,2
1 200 м	700	1 200 м	35	3 000 м	3,1
1 300 м	410			5 000 м	1,9
1 500 м	140			10 000 м	0,9
1 600 м	80				
1 700 м	48				
1 800 м	30				

На основании принятой для взрыва тротила зависимости давления ударной волны от расстояния и веса заряда специалисты установили, что тротиловый эквивалент атомной бомбы испытанной 29 августа 1949 г. конструкции, равен 11 000 тонн тротила.

(= Bomb's BLAST yield partition was 11 kt of TNT.)

Действие взрывной волны на военную технику

Из всех видов боевой техники *наиболее уязвимой оказалась авиационная* (самолеты): из 53 самолетов, установленных на опытном поле на дистанциях от 500 до 4 000 метров, остались неповрежденными только 2 самолета.

Артиллерийское вооружение полностью разрушено в радиусе 250–300 метров и значительно повреждено в радиусе 500 метров от центра взрыва. *Радиус* полного разрушения (*полного вывода из строя) танков – 250–300* метров. Средним танкам в радиусе 350–500 метров нанесены сильные повреждения.

Воздушные *линии связи* сильно разрушены в радиусе до 1 000 метров, а кабельные линии, проложенные на земле, в радиусе 500 метров.

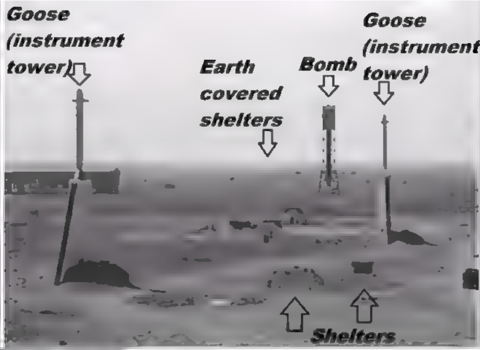
(= Military effects:
Out of 53 aircraft exposed at 0.5-2km range, only 2 survived intact.
Field artillery and tanks were destroyed at 250-300m and had significant damage out to 500m.
Ground-laid cables were destroyed out to 500m, and overhead cables were destroyed out to 1000m.)

***Animal Effects from Soviet Atmospheric Nuclear Tests*, by V. A. Logachev and L. A. Mikhalikhina, ITT Corporation, 2008, report ADA485845 (DTRA-TR-07-38):**

"The medical/biological studies involved about 8,000 experimental animals (camels, horses, pigs, sheep, dogs, rabbits, guinea pigs, white rats). The basic ways to solve medical/biological problems were by carrying out field experiments that used animals in open areas of test fields and in military and civilian protective structures. Animals were placed in more than 500 field and long-term structures, more than 200 war materiel items (tanks, armored personnel carriers, automobiles, aircrafts etc.), and residential brick and wooden houses."

Page 36: at the 1.6 megaton 1955 test, no thermal burns occurred to animals in houses or structures.

Recently declassified high quality photos of the effects of the 1949 Russian nuclear test RDS-1 on military equipment

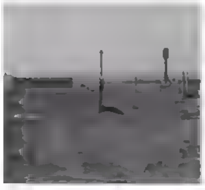


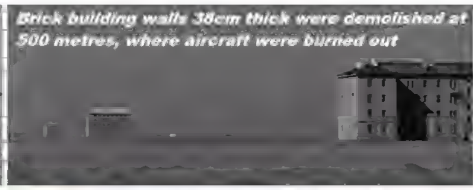
Trench field fortifications and bomb tower

Building protected by earth-filled blast walls

Entire brick house exposed to RDS1 in 1949

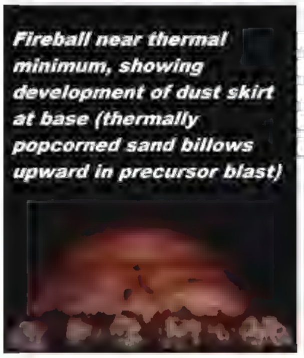
America did not bother to expose houses to nuclear tests until 47 kt Easy in 1951.





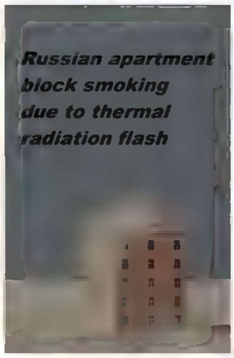
Brick building walls 38cm thick were demolished at 500 metres, where aircraft were burned out

Moscow type housing blocks exposed in 1949.



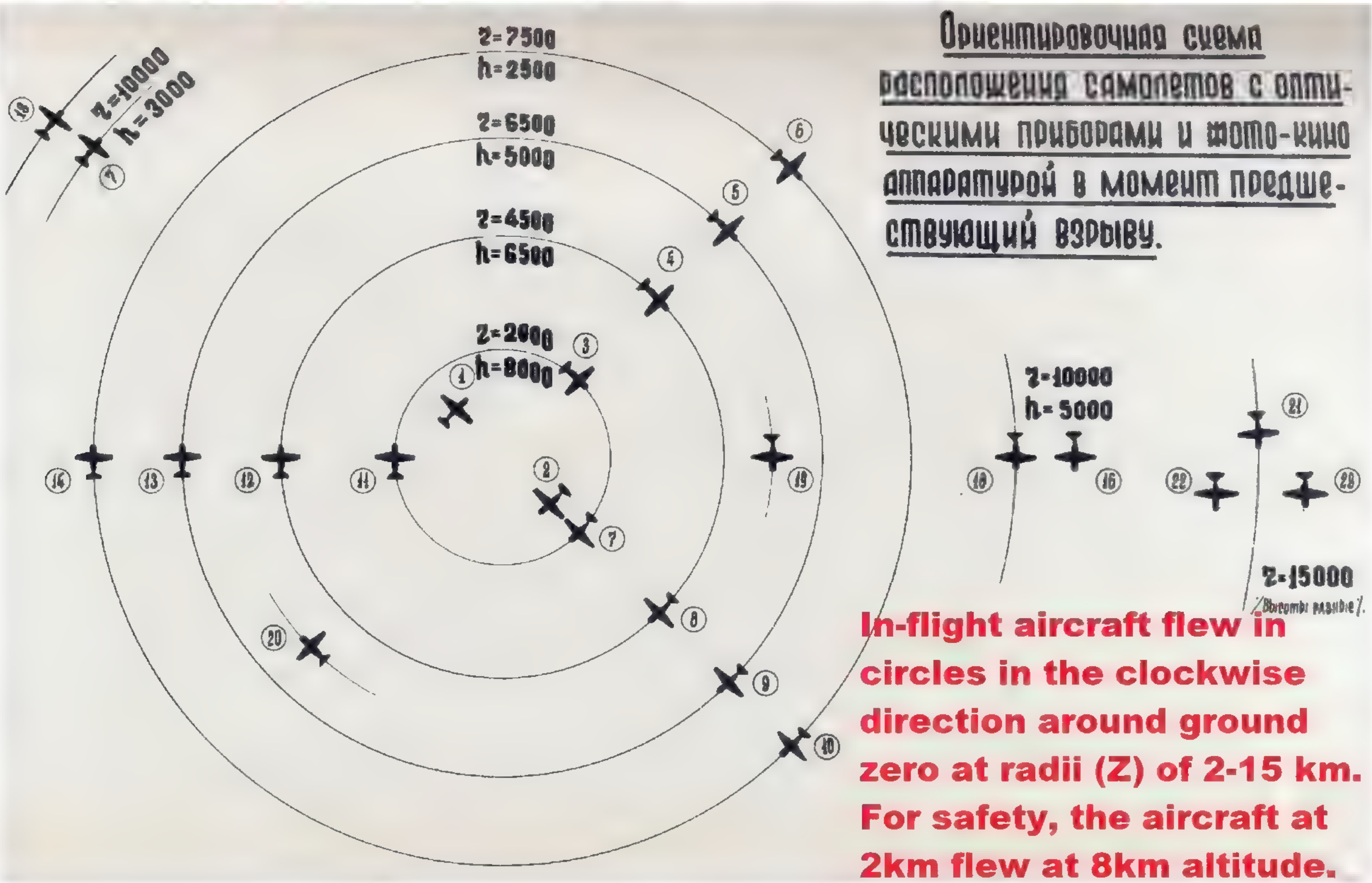
Fireball near thermal minimum, showing development of dust skirt at base (thermally popcorned sand billows upward in precursor blast)

Fireball brightens as the shock front expands beyond shell of nitrogen dioxide which absorbs thermal radiation while the overpressure is high



Russian apartment block smoking due to thermal radiation flash

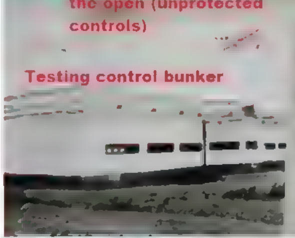
Russian apartment block engulfed by precursor blast wave

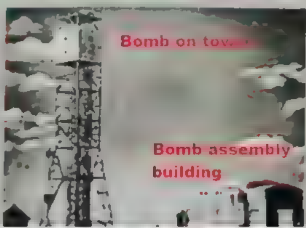


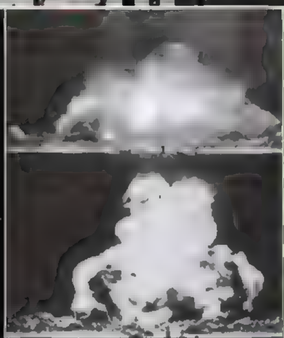
In-flight aircraft flew in circles in the clockwise direction around ground zero at radii (Z) of 2-15 km. For safety, the aircraft at 2km flew at 8km altitude.

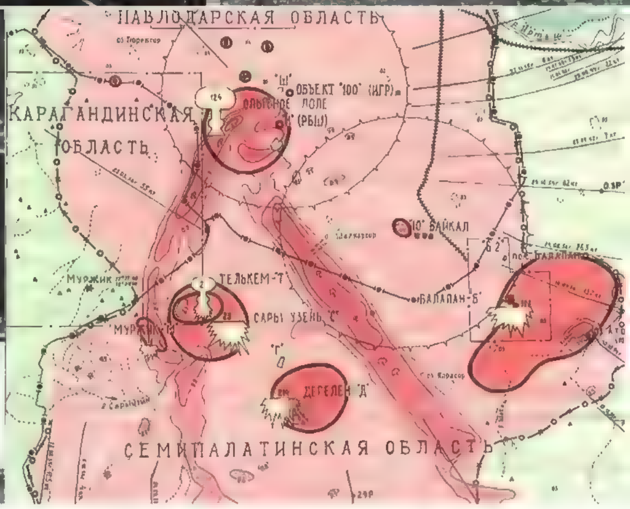
29 August 1949 first Russian test control bunker (left)

Right: 14 different target sectors or lines stretched out to distances of up to 10 km (6 miles) from the 29 August 1949 Russian 22 kt nuclear test tower. This Russian poster uses a non-linear distance scale to show the ranges to which different items were exposed. Tanks were sector 5, out to 2 km in the South-West.









RIGHT: Russian illustration of USA 15 kt Grable nuclear test shell, 1953. Note the oralloy (U235)

First tritium and deuterium gas boosted plutonium primary stage gave "amazing" 12 kt, 28 December 1957!

~~Сов. секретно~~
~~(Особой важности)~~

РАССЕКРЕЧЕНО

Рассекречено протокол 4(1)
Акт 2 ч.45 ГК Росатом
от 14.04.15 № 56 л. 287
Подпись [signature] 19.05.15

Товарищу ХРУЩЕВУ Н.С.

Товарищу БУЛГАНИНУ Н.А.

Докладываю, что 28 декабря 1957 года в 10 часов утра по московскому времени на полигоне № 2 Министерства обороны СССР, в соответствии с утвержденным планом, был произведен взрыв атомного устройства с целью изучения нового способа повышения эффективности использования плутония в атомных зарядах за счет добавления небольшого количества газообразной смеси дейтерия и трития.

Результат опыта положительный.

Прилагаю телеграмму тов.Соболева (руководитель испытания) и др., полученную с полигона о проведенном испытании.

[signature] Е.Славский

Исх. от. 936/3
31. XII. 57г.

Приложение в деле вход. шифртелеграмм | ШО архив

Доложено
30/XII

	1+2
	2/ш
	3.I.58г.

RUSSIAN 3.5 KT UNDERWATER TEST IN 1955

RUSSIAN 6 KT UNDERWATER TEST IN 1957

240

РАССЕКРЕЧЕНО

Сов.секретно
(Особая важность)

В ПРЕЗИДИУМ ЦК КПСС

Согласно Постановлению Совета Министров СССР от 20 мая 1954г. Министерство оборонной промышленности (НИИ-88, главный конструктор т.Королев С.П.) разрабатывает баллистическую ракету Р-7 для транспортировки специального заряда типа РДС-6 на дальность 8000 км.

По расчетным данным указанный заряд типа РДС-6 имеет мощность порядка 1,5 млн. тонн тротилового эквивалента и вес его вместе с аппаратурой автоматики был задан 3400 кг.

В результате проведенных в ноябре 1955г. испытаний водородной бомбы, построенной на новом принципе обжатия выявилась возможность создания для ракеты Р-7 нового водородного заряда мощностью около 2,0 млн. тонн тротилового эквивалента и весом 2900 кг.

В соответствии с решением ЦК КПСС от 5 января 1956г. вопрос о размещении нового водородного заряда в ракете Р-7 проработан НИИ-88 МОП совместно с представителями МСМ, при этом установлена возможность разместить новый заряд в головном отсеке ракеты.

Снижение веса нового заряда против ранее заданного веса заряда типа РДС-6 позволит увеличить дальность полета ракеты Р-7 на 200-300 км.

Применение в ракете Р-7 нового заряда не влечет за собой изменения срока начала зачетных испытаний, ранее установленного Правительством.

Просим рассмотреть и утвердить представляемый проект Постановления Центрального Комитета КПСС и Совета Министров СССР по данному вопросу.

М.Хруничев
К.Жуков
Б.Ванников
Д.Устинов
В.Рябиков
П.Зернов

"21" апреля 1956г.

241

РАССЕКРЕЧЕНО

Сов.секретно
(Особая важность)

ЦЕНТРАЛЬНЫЙ КОМИТЕТ КПСС и СОВЕТ МИНИСТРОВ СССР

ПОСТАНОВЛЕНИЕ №________

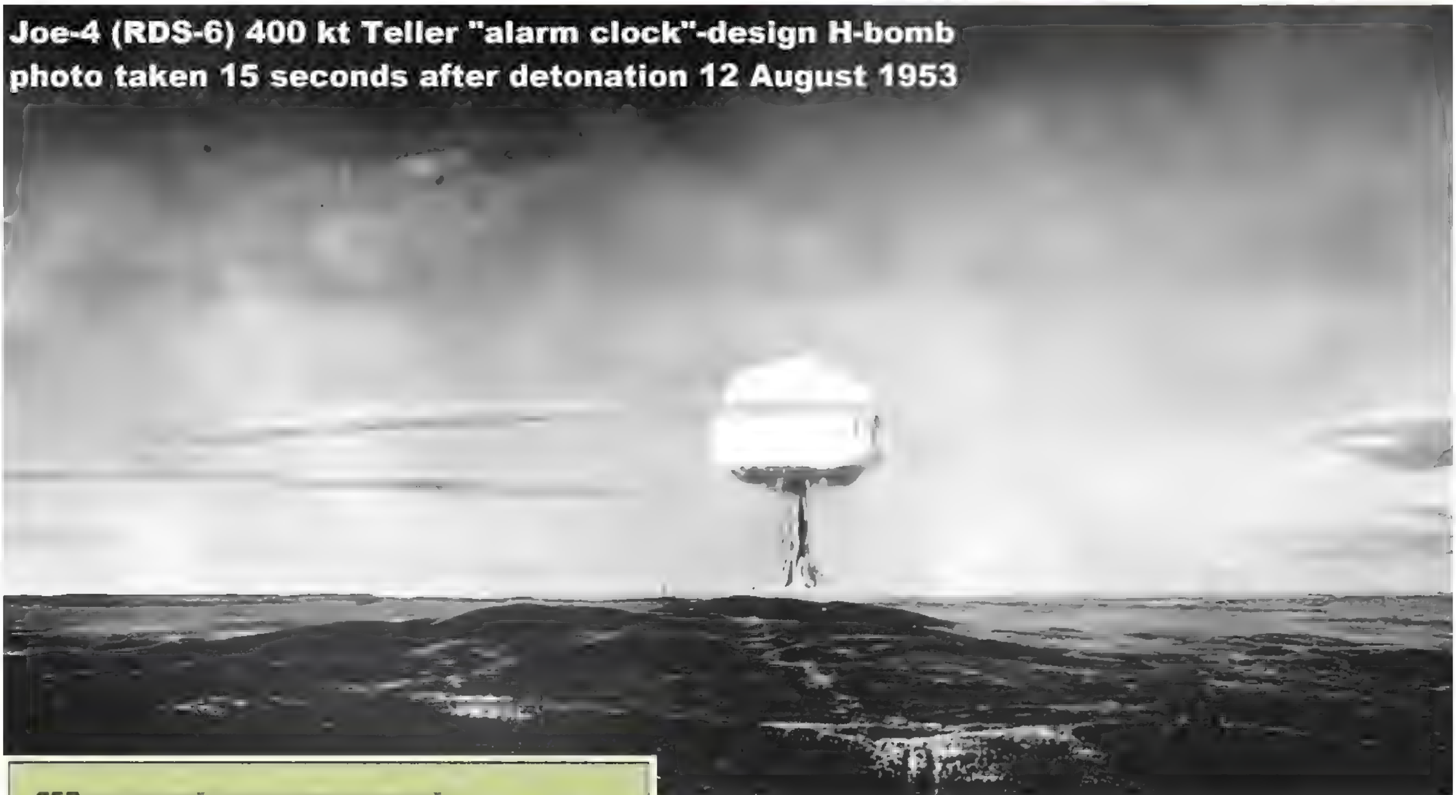
Москва, Кремль " "________1956г.

В целях вооружения баллистической ракеты Р-7 новым более мощным водородным зарядом Центральный Комитет КПСС и Совет Министров СССР, в частичное изменение Постановления Совета Министров СССР от 20 мая 1954 г. № 956-408сс, ПОСТАНОВЛЯЮТ:

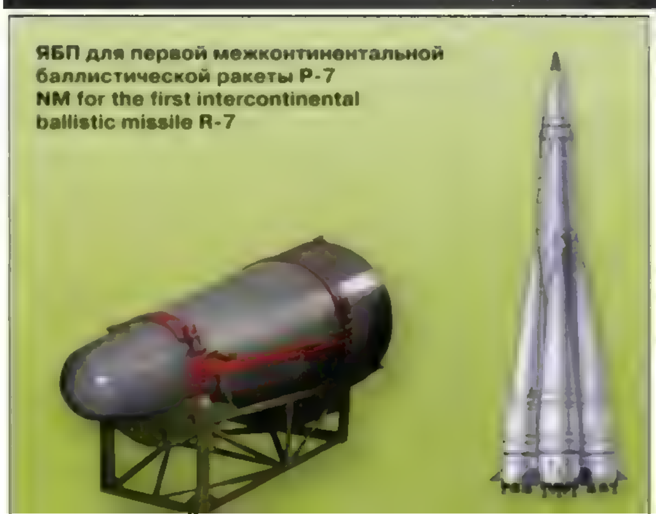
Принять предложение тт.Хруничева, Жукова, Ванникова, Устинова, Рябикова, Зернова о применении в баллистической ракете Р-7 нового водородного заряда мощностью около 2,0 млн тонн тротилового эквивалента, имеющего вес со спецаппаратурой (автоматика, взрывательные устройства, электропитание) не более 2900 кг, взамен специального заряда типа РДС-6 мощностью 1,5 млн. тонн тротилового эквивалента и весом 3400 кг, предназначавшегося ранее к установке на этой ракете.

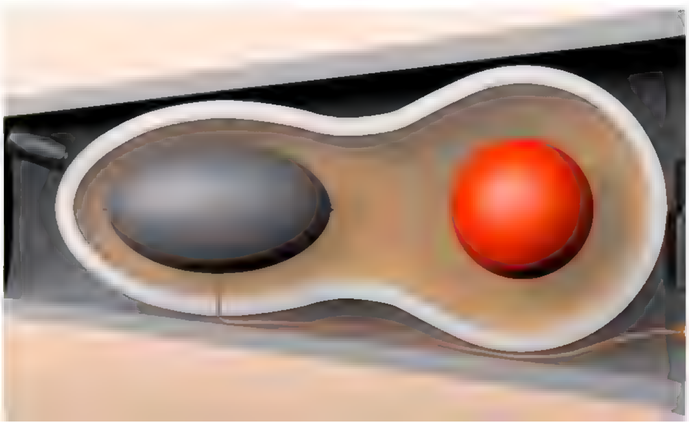
SECRET 1956 USSR Council of Ministers decision authority to equip their 8000 km range R-7 IRBM with their 2.0 megaton warhead with a mass of 2900 kg, based on their November 1955 "new ablation principle" thermonuclear weapon test.

Boris V. Litvinov showing Putin the world's smallest diameter (152.4mm) 2.5 kt artillery shell (above), and a 99.85% clean thermonuclear bomb (above right and right), 30 March 2000.



Joe-4 (RDS-6) 400 kt Teller "alarm clock"-design H-bomb photo taken 15 seconds after detonation 12 August 1953





B.V. Litvinov, President Putin, P.I. Sumin at RFNC-VNIITF, 30 March 2000

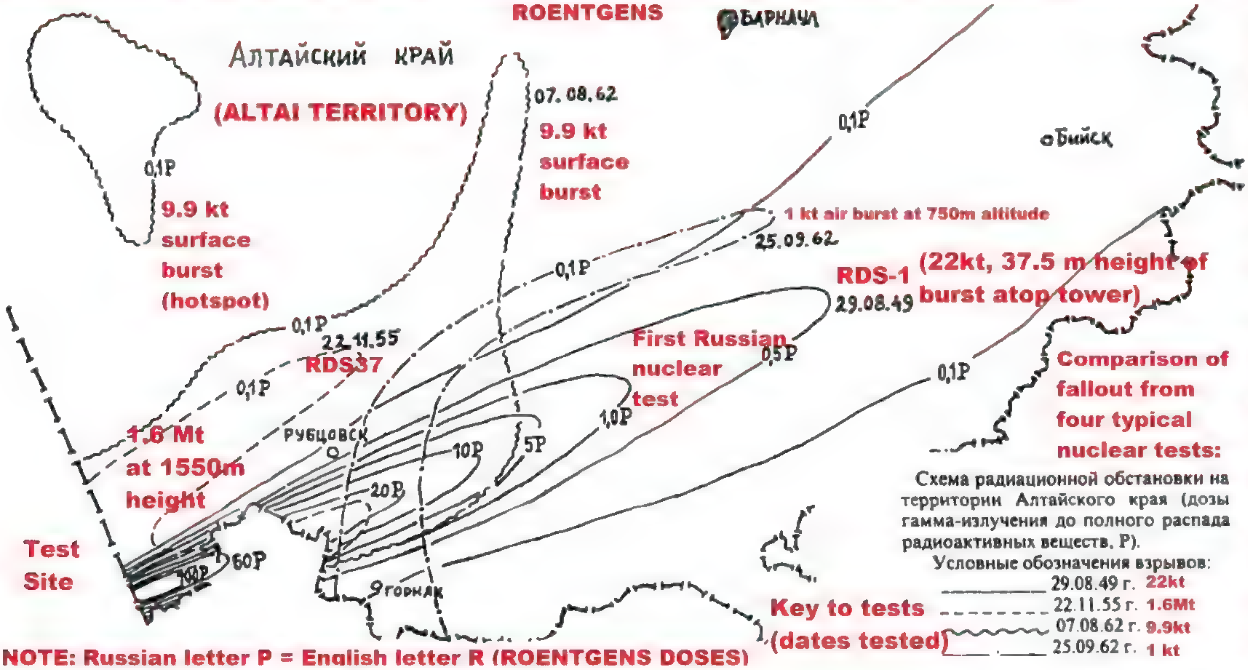
E.N. Avrorin, B.V. Litvinov, President Putin, G.N. Rykovanov, E.O. Adamov, Yu.V. Solomon

State visit of President Putin to RFNC-VNIITF, 30 March 2000

PRESIDENT PUTIN AWARDS NUCLEAR WARHEAD DESIGNER BORIS LITVINOV THE ORDER FOR MERIT TO THE FATHERLAND IN 2000.

For the 30 March 2000 state visit of President Putin to RFNC-VNIITF: B.K. Vodolaga, A.S. Shtanko, A.V. Oplanchuk, V.N. Zatsepin,M.E. Zheleznov, B.V. Litvinov, L.D. Ryabev, G.N. Rykovanov, N.P. Voloshin, E.N. Avrorin, THEM. Kamenskikh, V.Z. Kazachenkov, R.I. Wozniuk

COMPARISON OF INFINITE TIME FALLOUT GAMMA DOSES OUTDOORS FROM RDS1 AND RDS37 ROENTGENS



NOTE: Russian letter P = English letter R (ROENTGENS DOSES)

Note that the 1.6 megaton air burst RDS37 on 22 November 1955 produced ONLY 1% of the fallout doses of the 22 kt near surface burst RDS1. Burst height is more important than yield!

These measurements of the total (infinite time) dose were integrated according to the -1.2 power of time "decay law". Infinite time dose, D = 5Rt Roentgens, where R is initial dose rate (Roentgens/hour) at time t (hours after detonation).

The thermonuclear charge to equip the first domestic intercontinental ballistic missile (ICBM) R-7. The charge had a capacity of 3 megatons of TNT equivalent. The length of the rocket is 31.4 m. The range of the rocket was 8500 km. It launched Sputnik 1957 and the Vostok-1 spacecraft piloted by Gagarin in 1961.

The thermonuclear warhead for the first R-36 ICBM was tested in 1962 with a yield of 2 Mt. The range of the missile was 12,000 km.

Temp S: 300 kt Tactical, 12.3m long, 900 km range

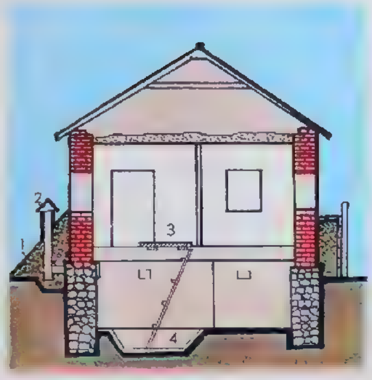
SOURCE: http://www.vniief.ru

ПРОТИВОРАДИАЦИОННЫЕ УКРЫТИЯ

Противорадиационными укрытиями называют сооружения, обеспечивающие защиту укрывающихся в них людей от заражения радиоактивными веществами и от облучения в зоне радиоактивного заражения местности.

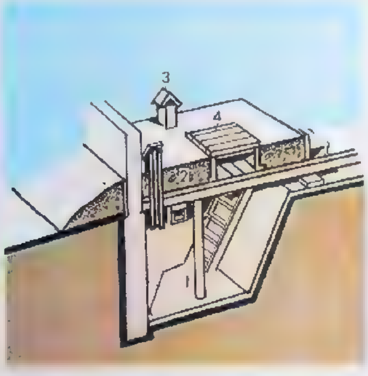
Под противорадиационные укрытия могут быть широко использованы приспособленные для защиты подвалы, подполья, погреба и другие углубления. Кроме того, укрытия могут возводиться с использованием лесоматериала, кирпича, бетонных и железобетонных элементов. В сельской местности укрытия строят из подручных материалов (круглый лес, жерди, хворост, камыш и др.).

ПРИСПОСОБЛЕННЫЕ ПОД УКРЫТИЯ ХОЗЯЙСТВЕННЫЕ СООРУЖЕНИЯ



Подвал каменного дома, приспособленный под укрытие:

1 — обсыпка грунтом; 2 — вытяжной короб; 3 — герметизированный люк; 4 — углубленный приямок



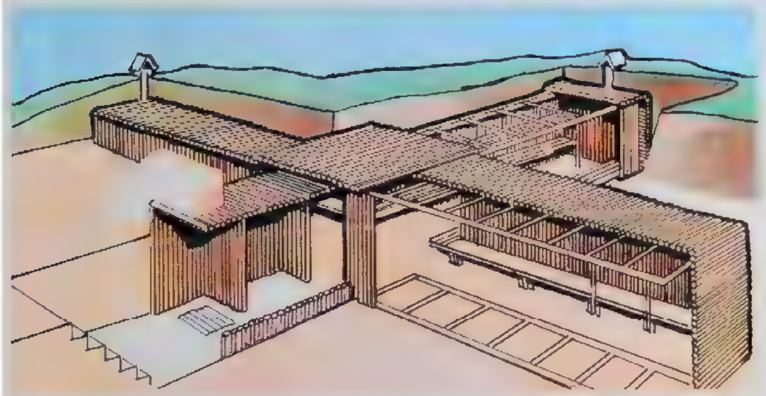
Приспособление подполья под укрытие:

1 — стойка усиления перекрытия; 2 — грунтовая засыпка; 3 — вентиляционный короб; 4 — дополнительная крышка люка

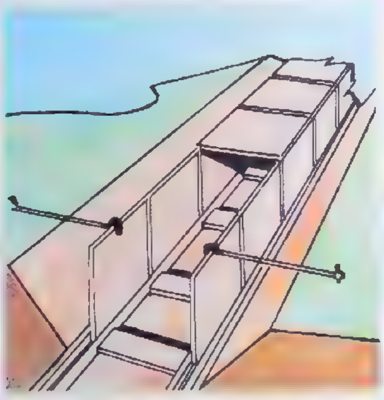
Отдельно стоящий погреб, приспособленный под укрытие

1 — места герметизации дверей; 2 — обсыпка грунтом (шлаком) 20 см; 3 — вытяжной короб; 4 — нары; 5 — отверстие для притока воздуха

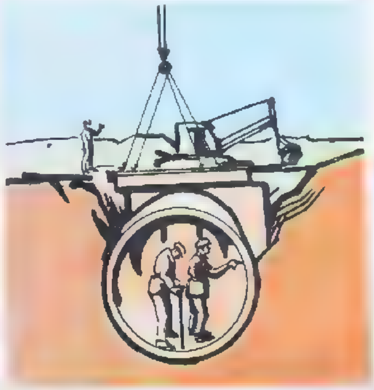
СТРОИТЕЛЬСТВО УКРЫТИЙ ИЗ ЛЕСОМАТЕРИАЛА И ЖЕЛЕЗОБЕТОННЫХ ЭЛЕМЕНТОВ



Укрытие безврубочной конструкции на 40 человек



Монтаж укрытия из железобетонных элементов



Железобетонные кольца, используемые при строительстве укрытий

При выборе места для строительства укрытий нужно учитывать влияние рельефа и осадков на характер радиоактивного заражения местности.

ПРОТИВОРАДИАЦИОННЫЕ УКРЫТИЯ

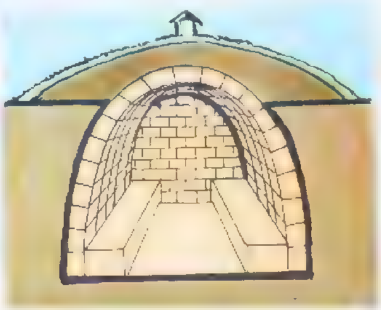
(ПРОДОЛЖЕНИЕ)

Население при угрозе нападения противника может своими силами строить из подручных материалов различного рода укрытия.

Щель

Землянка

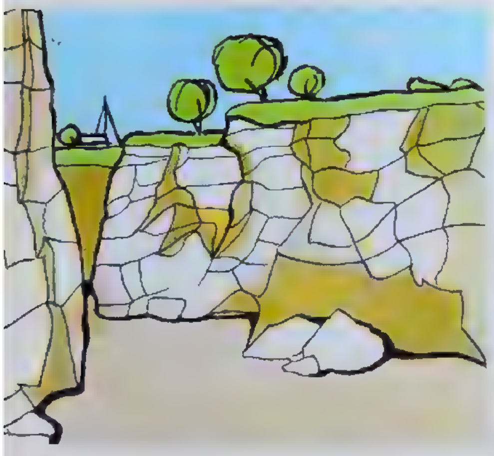
Укрытие из арочных фашин



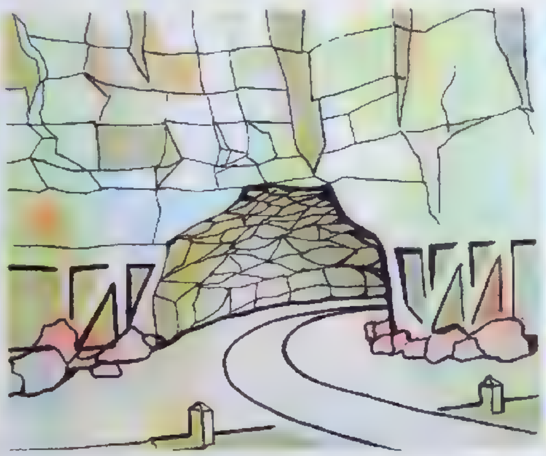
Укрытие из саманных блоков

Простейшие укрытия типа щели с одеждой крутостей ослабляют действие радиации в 100—200 раз, уменьшают радиус поражения от ударной волны в 1,5—2 раза

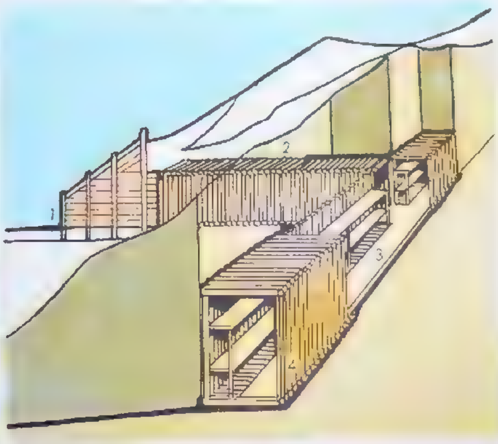
В районах горнодобывающей и угольной промышленности под укрытия могут быть использованы шахты, рудники, выработки по добыче строительных материалов, катакомбы, пещеры и др.



Меловые разработки



Соляные разработки



Галерея (разрез):

1 — вход; 2 — деревянные рамы; 3 — галерея; 4 — рамы из бревен или брусьев

Hard basement shelters in target cities. Simpler fallout shelters in rural area

Table 15.17. Command Post and Personnel Shelter Vulnerability Levels for Peak Overpressure (psi).

PERCENT PROBABILITY OF DAMAGE	LEVEL OF DAMAGE		
	LIGHT	MODERATE	SEVERE
10	20	35	40
50	30	50	60
90	45	75	90

Table 15.18. Hardened Frame/Fabric Shelter Vulnerability Levels for Peak Overpressure (psi).

PERCENT PROBABILITY OF DAMAGE	LEVEL OF DAMAGE		
	LIGHT	MODERATE	SEVERE
10	20	35	40
50	30	50	60
90	45	75	90

EXPEDIENT FIELD SHELTERS: 4 FT EARTH COVER

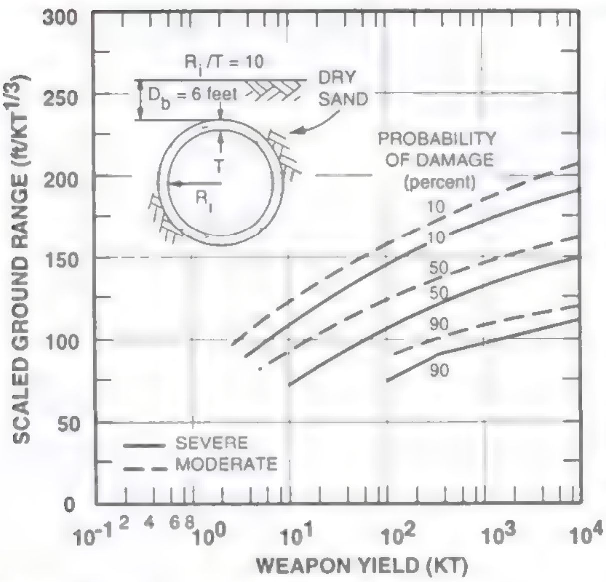


Figure 15.52. Vulnerability Curves for a Horizontal Cylinder, Aspect Ratio $R_i/T = 10$ (Structure Category 15.3.18) Buried in Dry Sand.

Russian buried KVS-U prefabricated buried corrugated steel shelter

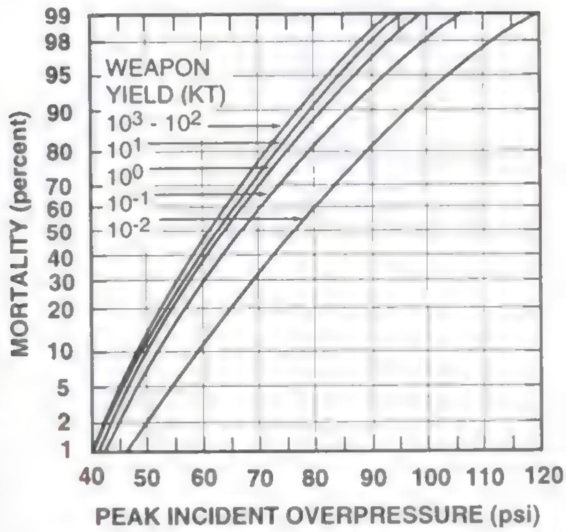


Figure 14.3. Mortality Due to Lung Injury; Long Axis of Body Parallel to Direction of Blast Wave.

July 1977 Commentary, pp 21-34:

Commentary

Why the Soviet Union Thinks It Could Fight and Win a Nuclear War

Richard Pipes

3. The threat of a second strike, which underpins the mutual-deterrence doctrine, may prove ineffectual. The side that has suffered the destruction of the bulk of its nuclear forces in a surprise first strike may find that it has so little of a deterrent left and the enemy so much, that the cost of striking back in retaliation would be exposing its own cities to total destruction by the enemy's third strike. The result could be a paralysis of will, and capitulation instead of a second strike.

Experts refute CIA – Soviet civil defense

NEW YORK NEWS WORKD, 19 February 1978

By Vicki Tatz
NEWS WORLD WASHINGTON BUREAU

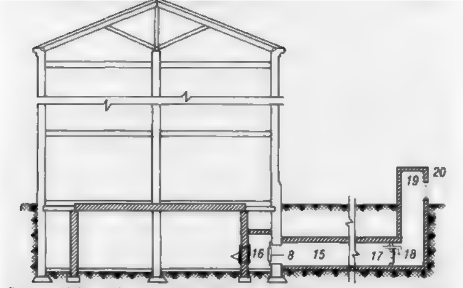
WASHINGTON—Two experts on Soviet civil defense capabilities disagreed sharply yesterday with statements released Friday indicating that the CIA does not place great significance on the massive Soviet preparations.

Dr. Eugenge Wigner, Nobel prize-winning physicist, and retired Gen. George Keegan, former chief of Air Force intelligence, both disagreed with Adm. Stansfield Turner, the director of the Central Intelligence Agency. In

"I don't know what the Soviets plan to initiate," Wigner said, "but the impression one gets is that they constantly claim that to destroy capitalist countries is all right, but to destroy socialism is a terrible crime."

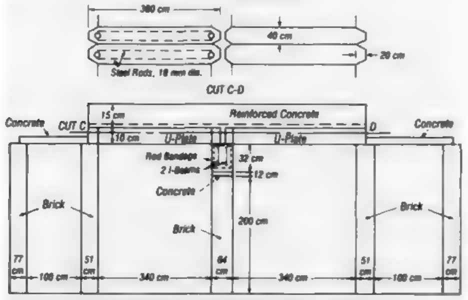
Wigner referred to estimates made by himself and others that only between 2 percent and 5 percent of the Soviet Union's population would be vulnerable to a U.S. nuclear attack, while 45 percent of the U.S. population could be hit.

In another telephone interview Gen. Keegan said there was not the



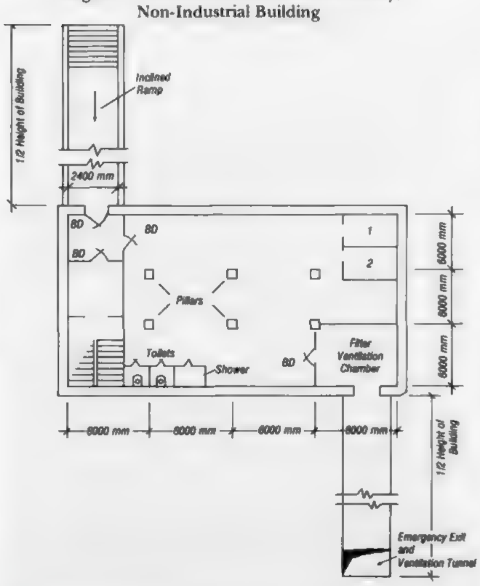
Basement Shelter in the center of a building basement: (1) compartments; (2) exits; (3) and (4) protective airtight doors; (5) louvered wooden door; (6) vestibule; (7) protective airtight shutters; (8) shutter with dust filter; (9) filter-ventilation chamber, (10) lavatories; (11) exhaust duct; (12) sealing safety valve; (13) basic air intake duct; (14) pressurized pipes; (15) emergency exit; (16) adjoining chamber; (17) airtight safety shutter in emergency exit; (18) floating cutoff valve; (19) vent cap of the emergency exit; (20) wooden louver grating

Basement Shelters



Cross Section of a Basement Shelter Using Prefabricated U-Plates and Cast Reinforced Concrete Slab Roof

Diagram of a Basement Shelter in a Six-Story, Non-Industrial Building

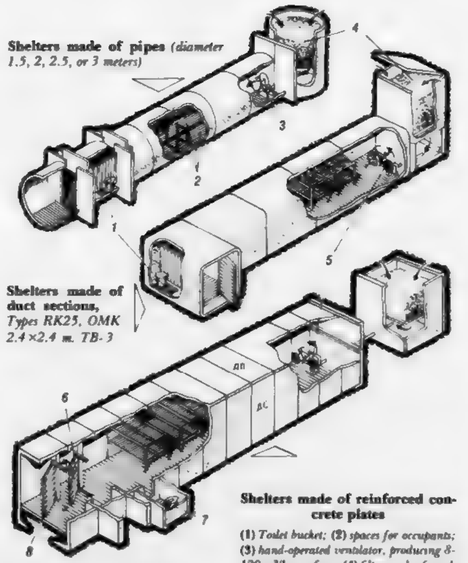


(1) storage for reserve of drinking water; (2) storage for a five-day supply of food; (BD) hermetically-sealing metal doors, height 1.8 m

Pillars of reinforced concrete 0.65 m × 0.65 m × 3m

REMARKS: All dimensions are in millimeters

Expedient Shelters



Shelters made of reinforced concrete plates

(1) Toilet bucket; (2) spaces for occupants; (3) hand-operated ventilator, producing 8-120 m³/hour of air; (4) filter made of sand, slag, with capacity of 150-220 m³/hour of air; (5) bicycle; (6) hermetic-sealing doors with air valve; (7) toilet; (8) protective door with hermetic seal

Dr Leon Goure, Shelters in Soviet War Survival Strategy, ADA053250, 1978.

TK Jones became President Reagan's civil defense expert, debunking propaganda:

1. Ostensible Crisis
2. Political, Economic, and Diplomatic Gestures
3. Solemn and Formal Declarations
4. Hardening of Positions—Confrontation of Wills
5. Show of Force
6. Significant Mobilization
7. "Legal" Harassment—Retortions
8. Harassing Acts of Violence
9. Dramatic Military Confrontations
10. Provocative Breaking Off of Diplomatic Relations
11. Super-Ready Status
12. Large Conventional War (or Actions)
13. Large Compound Escalation
14. Declaration of Limited Conventional War
15. Barely Nuclear War
16. Nuclear "Ultimatums"
17. Limited Evacuation (Approximately 20 per cent)
18. Spectacular Show or Demonstration of Force
19. "Justifiable" Counterforce Attacks
20. "Peaceful" World-Wide Embargo or Blockade
21. Local Nuclear War—Exemplary
22. Declaration of Limited Nuclear War
23. Local Nuclear War—Military
24. Unusual, Provocative, and Significant Countermeasures
25. Evacuation (Approximately 70 per cent)
26. Demonstration Attack on Zone of Interior
27. Exemplary Attack on Military
28. Exemplary Attacks Against Property
29. Exemplary Attacks on Population
30. Complete Evacuation (Approximately 95 per cent)
31. Reciprocal Reprisals
32. Formal Declaration of "General" War
33. Slow-Motion Counter-"Property" War
34. Slow-Motion Counterforce War
35. Constrained Force-Reduction Salvo
36. Constrained Disarming Attack
37. Counterforce-with-Avoidance Attack
38. Unmodified Counterforce Attack
39. Slow-Motion Countercity War
40. Countervalue Salvo
41. Augmented Disarming Attack
42. Civilian Devastation Attack
43. Some Other Kinds of Controlled General War
44. Spasm or Insensate War

Herman Kahn's Escalation Ladder of Steps the left will try to engineer to start WWIII.

BOEING AEROSPACE COMPANY

P O Box 3999
Seattle, Washington 98124

A Division of The Boeing Company

January 22, 1979

The Honorable William Proxmire
Chairman, Senate Banking Committee
United States Senate
Washington, D.C.

Dear Senator Proxmire:

Your request in recent hearings for an explanation of the discrepancy between our estimates and ACDA's estimates of Soviet losses in a nuclear war is clearly important and warrants a clear and candid answer. Unfortunately, Mr. Spurgeon Keeny, the Deputy Director of ACDA, chose to incorrectly represent our work. I appreciate the opportunity to set the record straight and to point out what we have determined to be the factors contributing significantly to the differences between the two estimates.

Population Protection

In his attempt to discredit our work, Mr. Keeny incorrectly inferred that this work was based on mere "assumptions" and "simple ratios." In fact, our approach was to analytically duplicate the provisions of the Soviet Union's civil defense plans and preparations. This effort was supported by extensive research into Soviet literature, use of rigorous system engineering functional analysis techniques, and a program of testing to establish the effectiveness of Soviet shelters and industrial protection methods. Moreover, the impact of uncertainties and possible imperfections in Soviet execution of their plans were examined parametrically.

Mr. Keeny's statement that we "assumed there would be no casualties from fallout" is false. The record of hearings before the Joint Committee on Defense Production (November 17, 1976) clearly shows that the data presented counted as fatalities all persons receiving a radiation dose of 200 rads or more. Moreover, our more recent studies of which ACDA is aware have treated this value parametrically.

By protecting their people against fallout, the Soviets can substantially limit their population fatalities. Figure 1 shows that even very rudimentary protection, such as basements or expedient shelters, is sufficient to minimize fatalities. In the ACDA analysis, the majority of the evacuees were assumed to have a protection factor of 10 or less, which results in enormously high fatalities compared to what the Soviets could achieve if they carry out even the most modest of the measures outlined in their plans and literature.

Assumption Variables Versus U.S.S.R. Civil Defense Effectiveness

Degree of Fallout Protection for Evacuees and Rural Population

BOEING

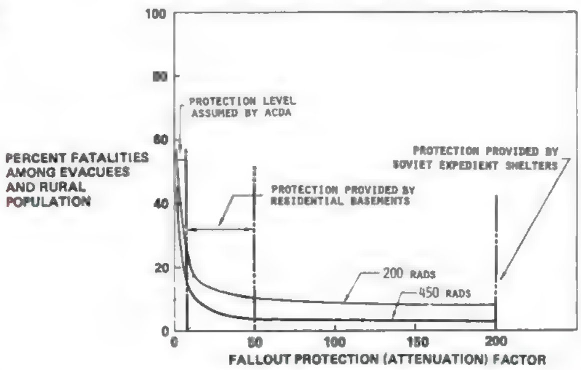


FIGURE 1

Mr. Keeny has incorrectly characterized our treatment of blast protection. In their cities, the Soviets are building industrial shelters and apartment basement shelters with a blast resistance of at least 150 psi and 60 psi, respectively. These ratings were calculated for the Defense Nuclear Agency based on knowledge of construction details such as beam dimensions, concrete quality, and structural reinforcement size and placement. The Soviet designs for expedient shelters have been built and exten-

Assumption Variables Versus U.S.S.R. Civil Defense Effectiveness

Distance Evacuated

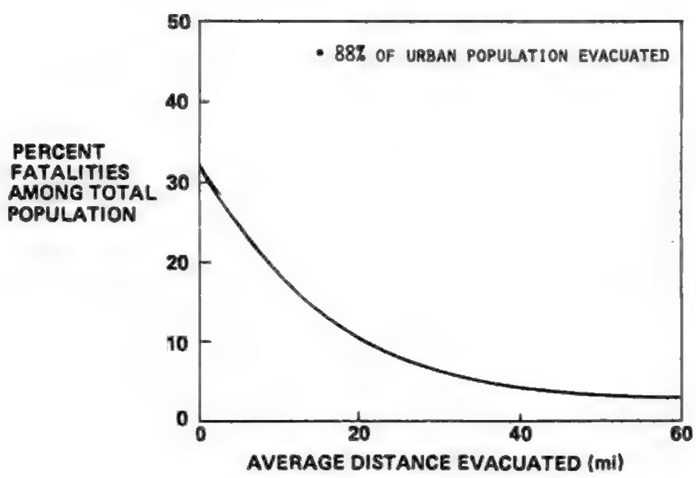


FIGURE 2

Assumption Variables Versus U.S.S.R. Civil Defense Effectiveness

Blast Protection Provided Evacuees and Rural Population

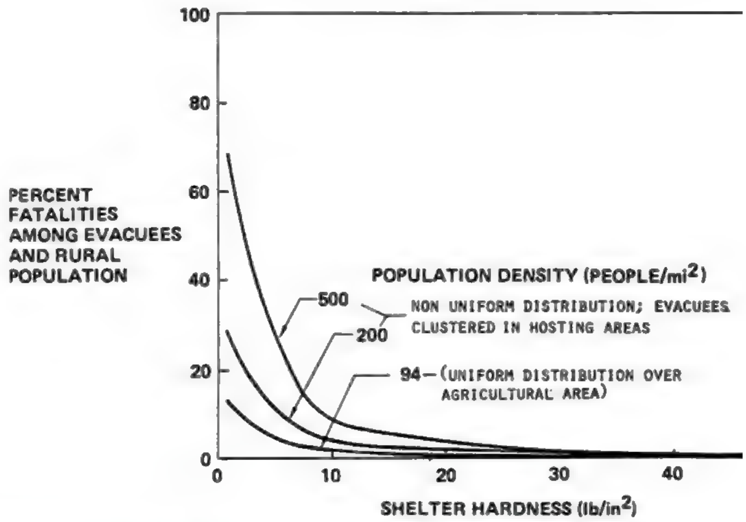


FIGURE 3

As to the reasons why our results differ from those produced by ACDA: ACDA assumed that 30 percent of the Soviet urban population would not be evacuated but that the good quality shelters would accommodate only 10 percent. Thus, 20 percent of the Soviet urban population was assumed unevacuated and inadequately protected, which of course subjects them to massive losses. The Soviet plans, which we endeavored to represent in our analysis, indicates that urban residents not sheltered will be evacuated.

A second difference centers around the way in which the Soviets choose to distribute and provide blast protection for their evacuees. The ACDA analysis assumed that the Soviets would cluster their evacuees in hosting areas, which we estimate could result in some concentrations as high as 500 persons per square mile. The evacuees were assumed to have no blast protection, so fatalities would occur at 3 to 7 psi according to the source used by ACDA. Figure 3 shows that a distribution of 500 persons per square mile and 3 psi fatal blast level results in a fatality level almost 100 times greater than a uniform distribution and blast protection to 15 psi (the minimum provided by Soviet expedient shelters). It is important to remember that it is the Soviet Union and not the United States that controls such factors as evacuation, distribution, and sheltering of the Soviet citizens.

The ACDA study of industrial protection, which I have reviewed, is not a competent work. The hardness levels known to be achievable on industrial components are seriously understated while the difficulty of achieving these levels is overstated. The resiliency of industry in recovering from damage is disregarded. The report's fixation on the capability of one-megaton weapons to damage industry is misleading since the U.S. would be able to deliver few of these weapons against Soviet targets. Moreover, the ACDA study fails to assess the impact of protection on the survival and recovery of the Soviet industrial base as a whole.

T. K. Jones

T. K. Jones

BOEING

TK JONES EXPOSED THE EVIDENCE DEBUNKING FAKE US ACDA/FEMA ANTI-CIVIL DEFENSE EFFECTS "DATA", USING EVIDENCE

USSBS Report 92, v2 Hiroshima buildings	MAE's in square miles	Radii of MAE's in feet
Multistory, earthquake-resistant	0.03	500
Multistory, steel- and reinforced-concrete frame (including both earthquake- and non-earthquake-resistant construction)	.05	700
1-story, light, steel-frame	3.4	5,500
Multistory, load-bearing, brick-wall	3.6	5,700
1-story, load-bearing, brick-wall	6.0	7,300
Wood-frame industrial-commercial (dimension-timber construction)	8.5	8,700
Wood-frame domestic buildings (wood-pole construction)	9.5	9,200
Residential construction	6.0	7,300

50% PROBABILITY OF SEVERE DAMAGE (COLLAPSE) FOR CITY BUILDINGS (SOURCE: NORTHROP, EM-1 NUCLEAR WEAPON EFFECTS HANDBOOK, 1996, TABLE 15.6, AND FIGURES 15.10, 15.18, SURFACE BURSTS)

	BUILDING VALUES (NOMINAL)			Peak overpressure (psi)	
STRUCTURE	Oscillation Period (ms)	Static yield resistance (psi)	Ductility ratio (u)	20 KT	1MT
15.2.2, 3-8 Story Reinforced Concrete Building (Concrete Walls)	300	3.0	7.5	15	12
15.2.10, 3-10 Story Steel Frame Building	600	2.0	10	23	13

THE ORIGINALLY SECRET EM-1 SHOWS THAT MODERN CITY BUILDINGS REQUIRE FAR HIGHER PEAK OVERPRESSURES, EVEN AT MEGATON YIELDS, THAN THE WOODEN HOUSES IN HIROSHIMA FOR COLLAPSE

Fig 3 Variation of mortality index with size of incident for explosives (from table E)

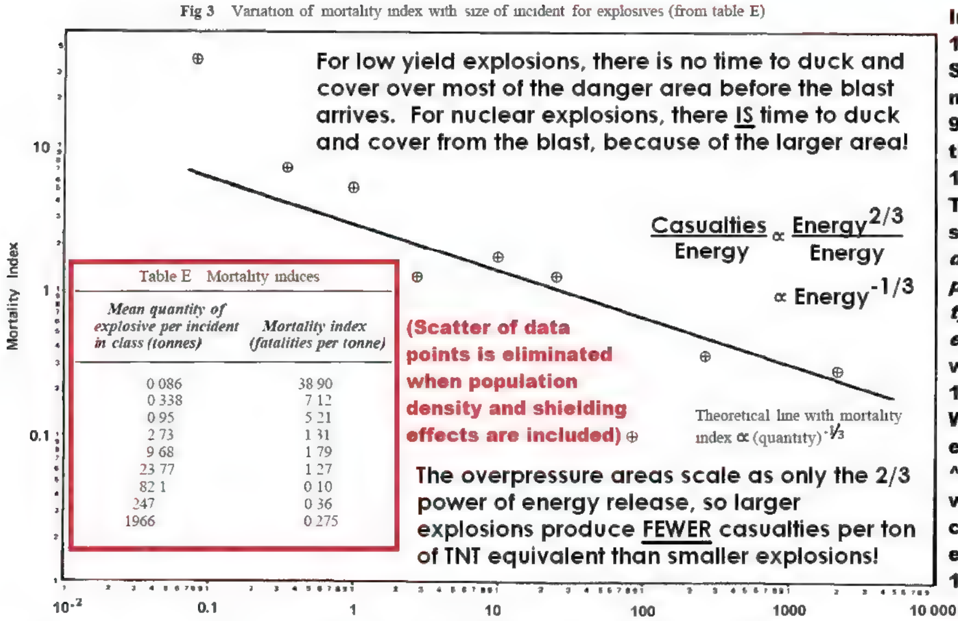


Table E Mortality indices

Mean quantity of explosive per incident in class (tonnes)	Mortality index (fatalities per tonne)
0.086	38.90
0.338	7.12
0.95	5.21
2.73	1.31
9.68	1.79
23.77	1.27
82.1	0.10
247	0.36
1966	0.275

In WWI, Britain's fired 170 million shells, of which 1.5 million were fired before the Battle of the Somme. In 1917 alone, Britain produced 50 million shells containing 185 kilotons of explosive. 943,947 shells were fired in a 24-hour period by the Britain on 28-29 September 1918. From 1914-17 Britain fired 290 kt at German trenches. The "equivalent megatonage" of these small smells is immense *because the area of destruction and thus casualties scale by the 2/3 power of energy, not directly with yield, and a typical WWI shell contained about 3.7 kg of explosive.* Thus, in 1917 alone British shelling was equivalent to: 50,000,000(3.7 x 10^-9)^{2/3} = 120 separate 1 megaton bombs. In the whole of WWI, Britain fired 170 million shells, with equivalent damage to: 170,000,000(3.7 x 10 ^-9)^{2/3} = 408 separate 1 megaton nuclear weapons. In Vietnam, 7,662,000 tons of conventional bombs = 766 separate 1 megaton explosions. In WWII, London received 18.8 kt in 100 kg bombs, thus 188,000(10^-7)^{2/3} = 4 thermonuclear weapons, each 1 megaton.

The 1.3 megatons of conventional bombs dropped on Germany in WWII was likewise equivalent to: 13,000,000(10^-7)^{2/3} = 280 separate thermonuclear weapons, each 1 megaton

SOURCE: https://glasstone.blogspot.com/2015/10/russian-anti-terrorism-policing-world.html

SOURCE:

Health & Safety Commission

Advisory Committee on Major Hazards

SECOND REPORT

HER MAJESTY'S STATIONERY OFFICE *1979*

The "equivalent megatonage" or equivalent to 1 megaton nuclear weapons, isn't just 0.29 megatons, but is immense because the area of destruction and thus casualties scale by only about the 2/3 power of energy, not directly with yield, and each average shell contained only 3.7 kg of explosive. Thus, the equivalent megatonnage of Britain's shelling in 1917 alone is:

$50{,}000{,}000(3.7 \times 10^{-9})^{2/3}$ = **120 separate 1 megaton nuclear weapons.** In the whole of WWI, the British Army fired 170 million shells, with equivalent damage to:

$170{,}000{,}000(3.7 \times 10^{-9})^{2/3}$ = **408 separate 1 megaton nuclear weapons.**

Now consider WWII, where London alone received about 18.8 kilotons in roughly 188 thousand separate 100 kg explosives in the 1940 Blitz :

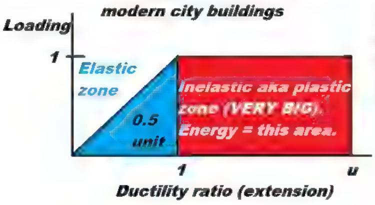
$188{,}000(10^{-7})^{2/3}$ = **4 thermonuclear weapons, each 1 megaton.**

The 1.3 megatons of conventional bombs dropped on Germany in WWII was likewise equivalent to:

$13{,}000{,}000(10^{-7})^{2/3}$ = **280 separate thermonuclear weapons, each 1 megaton.**

In total, 74.2 kilotons of conventional bombs were dropped on the UK in WWII causing 60,000 casualties, equivalent to 16 separate 1 megaton nuclear weapons, confirming the British Home Office analysis that - given cheap-type civil defence - you get about 3,750 casualties for a one megaton nuclear weapon. Naturally, without civil defence, as in early air bombing surprise attacks or the first use of nuclear weapons against Hiroshima and Nagasaki, casualty rates can be over 100 times higher than this. (For example, Glasstone and Dolan, in *The Effects of Nuclear Weapons, 1977* point out that in Hiroshima the 50% lethal radius was only 0.12 mile for people under cover in concrete buildings, compared to 1.3 miles for those caught totally unprotected outdoors. The difference in areas is over a factor of 100, indicating that the casualties in Hiroshima could have been reduced enormously if the people had taken cover in concrete buildings, or simple earth covered WWII shelters which offered similar protection to concrete buildings.)

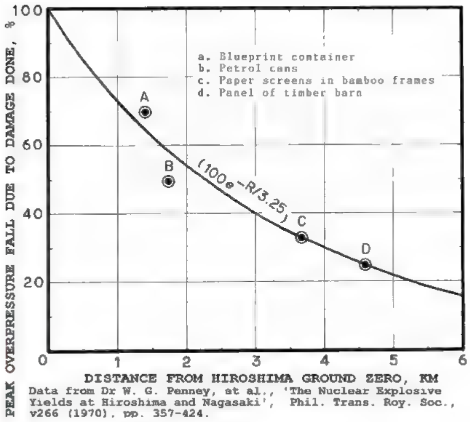
EM-1: ratio of energy to flatten vs. oscillate modern city buildings



Total blast wave energy absorbed by a city building, divided into the blast energy that can be absorbed to merely oscillate (in the elastic zone) a building = blue plus red areas, divided into blue area

= [0.5 + (u - 1)] / 0.5

= 1 + 2(u - 1)



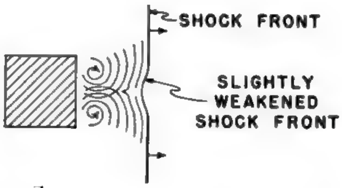
total blast energy — *dynamic pressure* — *overpressure*

$$E = 4\pi \int_0^R \left(\frac{1}{2}\rho u^2\right) r^2\, dr + 4\pi \int_0^R \frac{p}{\gamma - 1} r^2\, dr$$

KINETIC ENERGY **INTERNAL ENERGY**

The Effects of Atomic Weapons

PREPARED FOR AND IN COOPERATION WITH THE U. S. DEPARTMENT OF DEFENSE AND THE U. S. ATOMIC ENERGY COMMISSION

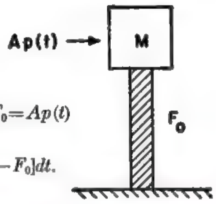


d

igure 5.3. Behavior of blast wave upon striking cubical structure: (*a*) before striking the structure; (*b*) soon after striking the structure; (*c*) soon after passing the structure; (*d*) wave completely past the structure.

APPENDIX A[1]

AN APPROXIMATE METHOD OF COMPUTING THE DEFORMATION OF A STRUCTURE BY A BLAST WAVE



$$M\frac{d^2x}{dt^2} + F_0 = Ap(t)$$

$$v = \frac{1}{M}\int_0^t [Ap(t) - F_0]\,dt.$$

Figure A.2. Mass supported on plastic spring equivalent to single-story structure.

Glasstone's 1950 *Effects of Atomic Weapons* explained the basis of blast attenuation clearly.

GENERAL CONSIDERATIONS

3.20 In the preceding paragraphs, the discussion has dealt with the air blast from an atomic bomb exploded in an infinite atmosphere. In this section consideration will be given to the influence of the height of burst of the bomb on the area of blast damage. The problem is extremely complex and can be solved only in a statistical or average manner. This is so for two reasons: first, the detailed description of a military target can never be completely given, and second, the complete analytical solution of even such a relatively simple problem as the behavior of a shock wave incident on a wall at an oblique angle has never been obtained for all angles. As will be seen later, a solution of the basic problem of shock reflection from a rigid wall can be derived by a combination of theory and experiment. This solution is, however, not readily adapted to yielding the effect of blast in better than an average sense in a more complicated situation. As to the detailed description of the target, not only are the structures of odd shape, but they have the additional complicating property of not being rigid. This means that they do not merely deflect the shock wave, but they also absorb energy from it at each reflection.

3.21 The removal of energy from the blast in this manner decreases the shock pressure at any given distance from the point of detonation to a value somewhat below that which it would have in the absence of dissipative objects, such as buildings. The presence

[11] This section is based on work by J. von Neumann and F. Reines done at the Los Alamos Scientific Laboratory.

of such dissipation or diffraction makes it necessary to consider somewhat higher values of the pressure than would be required to produce a desired effect if there were only one structure set by itself on a rigid plane.

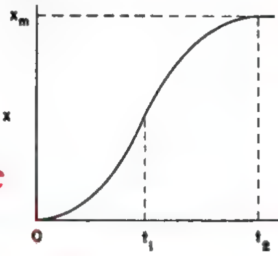


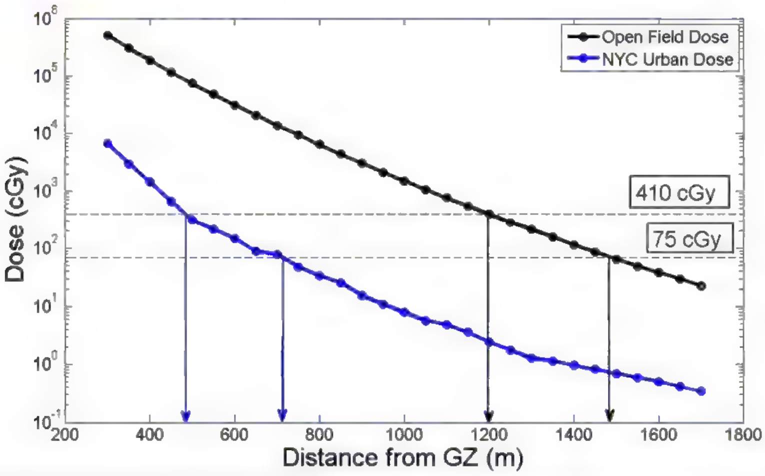
Figure A.5. Displacement of center of mass as function of tim

Glasstone's 1950 Appendix A calculates deflection of building, allowing energy absorbed to be calculated from: $E = \int F\,dx = \int PA\,dx$

Appendix A then gives a specifical calculated example: a reinforced concrete building of 952 metric tons, 75x75ft, 38 ft high, resisting force 4psi, subjected to a peak overpressure and dynamic pressure loading of 32psi decaying to zero in 0.32 second. Calculated peak deflection of middle of the building was 0.88 foot.

UNCLASSIFIED

Significant Reduction in Total Dose



Blast is not the only thing that is attenuated severely in a city: radiation including thermal and nuclear, is also attenuated. Although some scattered radiation gets through, it is usually degraded in energy and only comes from the small area of sky above you in a city street with tall buildings

UNCLASSIFIED

EXTRACTS

Table B-1. Severe/Moderate Blast Damage Radii for Surface Bursts (metesr)

Material classification		ALPHA 0.01	BRAVO 0.05	CHARLIE 0.10	DELTA 0.50	ECHO 1 KT
Field fortifcations	Mod	35	55	70	85	125
Earth covered surface shelters	Sev	35	60	65	80	100
Monumental-type multistory wall-bearing bldgs.	Mod	150	210	250	350	575
Multistory, wall-bearing bldgs (apt house type)	Sev	100	165	200	275	400
Multistory, reinforced bldgs (small windown area) Multistory, steel frame office bldgs.	Mod	65	100	130	200	350
Wood frame bldgs.	Sev	140	195	250	350	690

SOURCE: U.S. ARMY FIELD MANUAL "FM 5-26, EMPLOYMENT OF ATOMIC DEMOLITION MUNITIONS (ADM), AUGUST 1971".

PROTECTION (CASUALTY REDUCTION FACTOR) = AREA OF SEVERE DAMAGE FOR HIROSHIMA'S WOOD FRAME BUILDINGS / AREA OF SEVERE DAMAGE FOR EARTH COVERED SURFACE SHELTERS

$= 690^2 / 100^2 = 6.9^2 \sim 50$ FOR A 1 KILOTON SURFACE BURST.

SO MOVING TO EARTH COVERED SHELTERS REDUCES CASUALTIES TO 2%, AND THEY ALSO PROVIDE RADIATION SHIELDING. IN ADDITION, THE "FIRESTORM" AND ITS "SOOT NUCLEAR WINTER" FANTASY, WERE DEBUNKED BY GEORGE R. STANBURY, WHO PLANNED THE GERMAN FIRESTORMS; YOU NEEDED 50% IGNITION OF MEDIEVAL WOODEN HOUSES IN HAMBURG TO START A FIRESTORM, WHEREAS THE SIMPLE FIREBALL SHADOWING OF HIGH-RISE MODERN CITY SKYLINES REDUCES THIS TO 5% OR LESS, PREVENTING FIRESTORMS AND CLIMATIC EFFECTS. THIS IS SUPPRESSED BY THE NUCLEAR EXAGGERATIONS BIAS OF JOURNALISTS.

CHANGE 1

Field Manual No 101-31-1

NUCLEAR WEAPONS EMPLOYMENT DOCTRINE AND PROCEDURES

Radius of vulnerability (emergency risk criterion: 5% combat ineffectiveness)

Figure 54. Radii of Vulnerability.

CATEGORY — **PERSONNEL (LL) IN—** (Based on Governing Effect)

Radii listed are distances at which a 5 percent incidence of effect occurs. HOB used is $60W^{1/3}$ meters.

Yield (KT)	Open	Open Foxholes	APCs	Tanks	Earth Shelter
	(Distances are in meters)				
0.1	700	600	600	500	300
1	1200	900	900	800	500
10	3200	1300	1300	1250	900
20	4000	1500	1450	1400	1000
100	8000	1900	1800	1800	1400
200	12000	2000	1900	1900	1500
300	14000	2100	1950	1950	1600

Protective factor = ratio of area of effect in the open, to area of effect for shelter

Example: for 300 kt, the protective factor of open foxholes is equal to $(14{,}000)^2/(2{,}100)^2 = 44$.

Open	Open Foxholes	APCs	Tanks	Earth Shelter	Yield (KT)
1	1.36	1.36	1.96	5.44	0.1
1	1.78	1.78	2.25	5.76	1
1	6.06	6.06	6.55	12.6	10
1	7.11	7.61	8.16	16.0	20
1	17.7	19.8	19.8	32.7	100
1	36.0	39.9	39.9	64.0	200
1	44.4	51.5	51.5	76.6	300

Calculation of the injury-averting protective factors by simple open foxholes and earth shelters, as a function of weapon yield. Most countermeasures are relatively ineffective against tactical nuclear wapons (due to the predominating neutron radiation effect at 0.1 kt yield), but are extremely effective against strategic nuclear weapons with yields of 100, 200 and 300 kt (protective factors of 44 to 77).

The definition of protective factor used here is the factor by which casualties numbers are reduced.

Secret

TIER
10/6

Intelligence Memorandum

Office of Transnational Issues *30 August 2000*

(b)(1)
(b)(3)

Evidence of Russian Development of New Subkiloton Nuclear Warheads

CIA OTI IN 2000-011 X

public statements by Russian scientists and officials since 1993 indicate that the last nuclear warhead designed during the Soviet era was a device tailored for enhanced output of high-energy X-rays with a total yield of only 300 tons.

Judging from Russian writings since 1995 and Moscow's evolving nuclear doctrine, new roles are emerging for very-low-yield nuclear weapons—including weapons with tailored radiation output—and there are powerful advocates for development of such weapons in the country's military and weapons community. The Moscow press claimed that a draft presidential edict from Yel'tsin called for "development of new-generation nuclear weapons."

- Recent statements on Russia's evolving nuclear weapons doctrine lower the threshold for first use of nuclear weapons and blur the boundary between nuclear and conventional warfare. Very-low-yield nuclear weapons reportedly could be used to head off a major conflict and avoid a full-scale nuclear war.

In the post-Soviet era, the need for subkiloton nuclear weapons with minimal long-term contamination has been argued in the media by senior Ministry of Atomic Energy (Minatom) officials, nuclear weapons scientists, and military academics since the mid-1990s. Advocates often claim to know that the United States is developing the next generation of nuclear weapons and argue that Russia must not lag behind. Somewhat inconsistently, they also cite clean, very-low-yield weapons as an "asymmetric response" to US superiority in conventional weapons. According to Sergei Rogachev, Deputy Director of the Arzamas-16 nuclear weapons design laboratory: "Russia views the tactical use of nuclear weapons as a viable alternative to advanced conventional weapons."

- Senior Russian military officers have advocated the use of highly-accurate, super-low-yield nuclear weapons in Russian military journals such as *Military Thought* and *Armeyskiy Sbornik*. Deputy Commander in Chief of the Strategic Rocket Forces Muravyev stated that to have an effective impact across the entire spectrum of targets, strategic missile systems should be capable of conducting surgical strikes in a wide spectrum of ranges with minimal ecological consequences, which could be achieved with low-yield nuclear weapons.

Soviet Era Development of Tailored - Output Nuclear Devices

Russian development of nuclear devices tailored to enhance certain types of radiation output began during the Soviet period when "clean" nuclear devices—that is with reduced contamination from fission products—were needed for peaceful nuclear explosions (PNE's), according to statements by the developers. Clean PNE devices were in effect the first enhanced-radiation devices produced in Russia and likely precursors of tailored-output devices developed later for both effects testing and weapons development, which involved the same scientists (see appendix B for detailed discussion).

Enhanced-radiation weapons are designed to increase the effective range of gamma, neutron, X-ray, or electromagnetic pulse effects beyond the range of the airblast and fireball effects. Clean PNE devices are designed to minimize contamination from fission products by maximizing the fraction of the total yield produced by fusion. The two objectives are achieved by similar design approaches.

- Former Atomic Energy Minister Mikhaylov, other nuclear scientists, military officers, and national security commentators have described these new weapons as blurring the boundaries between conventional and nuclear war. In a 1996 treatise, Mikhaylov advocated developing a new generation of nuclear battlefield arms with relatively low yields that would change the perception of nuclear arms as weapons of mass destruction. In 1999, he claimed that these new-generation nuclear charges would sharply lower the psychological threshold of nuclear weapons use and would increase the likelihood of a nuclear strike in a local conflict, according to an independent Russian military newspaper.

- *The development of low-yield warheads that could be used on high-precision weapon systems would be consistent with Russia's increasing reliance on nuclear weapons to deter conventional as well as nuclear attacks, especially given widespread perceptions of a heightened threat from NATO and the reduced capabilities of Russian conventional forces.* Russia has no prospect of restoring its conventional military capabilities in the foreseeable future, nor of matching the West in the procurement and deployment of advanced weapon systems that can be brought to bear at the nonnuclear level.

The possible diverse applications for subkiloton nuclear weapons devices range from tactical battlefield weapons to antisatellite weapons. Media reports have noted that current modernization plans will affect Russia's entire stockpile, from tactical to strategic weapons. According to the December 1999 issue of the Army Journal *Armeyskiy Sbornik:*

> "For an effective impact across the entire spectrum of targets, strategic missile systems should be capable of conducting 'surgical' strikes over a wide spectrum of ranges in the shortest period of time with minimal ecological consequences. This is achieved by using highly accurate, super-low-yield nuclear weapons, as well as conventional ones, and requires the highest accuracy."

The range of applications will ultimately be determined by Russia's evolving nuclear doctrine, and could include artillery, air-to-air missiles, ABM weapons, anti-satellite weapons, or multiple rocket launchers against tanks or massed troops.

NOTE: the last Russian nuclear weapon test in Ukraine was on 16 September 1979, "coincidentally" the same 0.3 kiloton (300 tons of TNT) yield as the new Russian battlefield tactical nuclear warheads! Because of the atmospheric nuclear test ban at that time, it was set off 900m below ground in the Ukrainian coal mine at Yunkom in Donetsk as a "safety precaution" allegedly to release methane gas! This mine "resumed normal operations" the next day.

Russia's Evolving Nuclear Doctrine

Since the dissolution of the USSR in 1991, Moscow's military doctrine has undergone a major shift with respect to the possible use of nuclear weapons. The deterioration of Russia's conventional military capabilities led to the adoption of a broadened concept of nuclear deterrence as early as the fall of 1992. Russia's nuclear arsenal was invoked to deter any large-scale conventional aggression in addition to nuclear attacks.

This concept in turn necessitated a rethinking of the old Soviet pledge—initially endorsed by President Yel'tsin—that Moscow would never be the first to use nuclear weapons. A November 1993 statement of *Basic Provisions of the Military Doctrine of the Russian Federation* clearly departed from the decade-old pledge never to be the first to use nuclear weapons and adopted a broadened concept of nuclear deterrence covering large-scale, nonnuclear threats to Russia. As a warning to potential adversaries, Moscow indicated it might use nuclear weapons first if an aggressor takes actions to destroy or disrupt operation of Russia's strategic nuclear forces, missile attack warning system, or nuclear and chemical industries.

WASHINGTON SCENE...*from the AIAA Washington*

ASTRONAUTICS & AERONAUTICS
January 1981

- CIA Deputy Director John McMahon, in testimony before a House Intelligence Subcommittee, estimated that the Soviet Union had spent $200 million on propaganda and covert campaigns against NATO deployment of enhanced-radiation (neutron-bomb) weapons and the modernization of theater nuclear weapons.

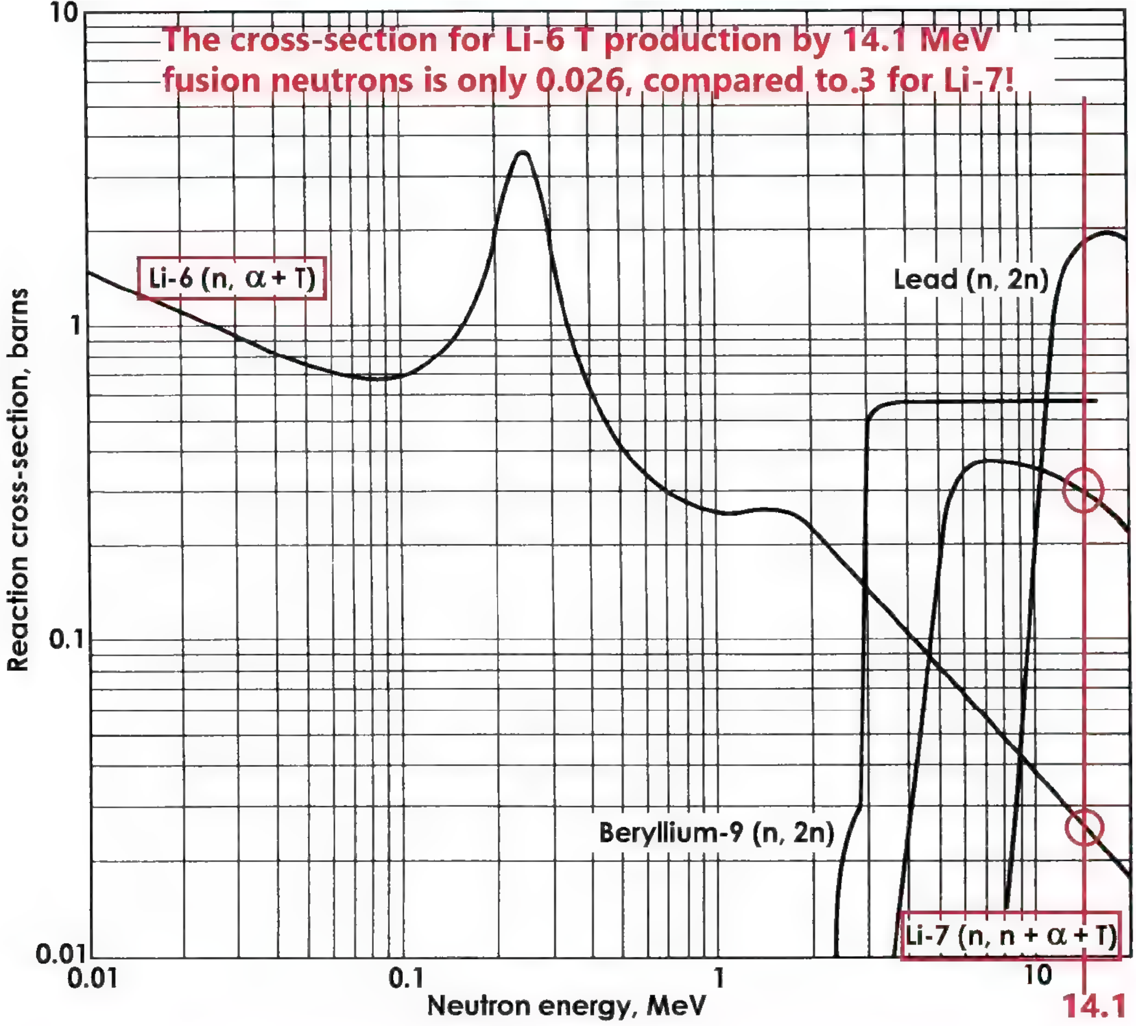
Enhanced radiation weapons (ERW) increase radiation while greatly reducing blast (tenfold) and heat damage to surrounding areas. Made for use in short-range, tactical nuclear weapons such as the Lance missile and 8-in. howitzer, they would probably be used against large concentrations of Warsaw Pact tanks, a major threat to NATO.

The campaign against the neutron bomb began in the summer of 1977 and was manifested in a series of coordinated diplomatic moves, overt propaganda, and covert political action, said McMahon. It began in the Soviet and East European press and spread to communist international front groups all over the world. "The purpose of this front-group activity was to maintain the campaign's momentum and to draw noncommunists into the campaign, particularly in Western Europe. What had begun as a Soviet effort now appeared to many as a general public reaction to the alleged horrors of the neutron bomb," said McMahon.

By far the most important comments, said McMahon, appeared in the noncommunist press in the political center

While it is difficult to assess the full impact of the anti-neutron-bomb campaign, the Carter Administration in April of 1978 deferred production of the enhanced-radiation element of the warheads indefinitely while proceeding with modifications to the warheads themselves to make them compatible with ER components. In commenting on the results of the Soviet bloc campaign, the CIA testimony quoted the chief of the International Department of the Hungarian Communist Party, Janos Berecz, as saying, "The political campaign against the neutron bomb was one of the most significant and most successful since World War II." McMahon also noted that "the Soviet Ambassador to the Hague (Netherlands) at that time was subsequently decorated by the CPSU (Communist Party of the Soviet Union) in recognition of the success of the Dutch Communist Party, under his direction, in organizing the high point of the anti-neutron bomb campaign."

With the neutron bomb temporarily defused, testified McMahon, the Soviet Bloc turned its efforts against the U.S.-initiated move to modernize the theater nuclear forces (TNF) by deploying the highly accurate ground-launched cruise missile (GLCM) and the Pershing II missile. Scheduled for deployment in late 1983, they will, for the first time, place targets on Soviet soil within range of NATO ground-based missiles. The purpose of the modernization is to minimize the



Proved in the successful 9.96 megaton Ripple II secondary stage test (99.9% clean bomb, employing 10 kt boosted Kinglet primary) by John Nuckolls; Dominic Housatonic, on 30 October 1962.

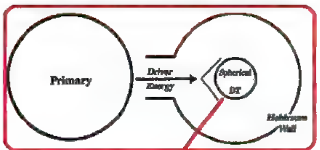
The Ripple II nuclear test secret: why lithium-7 is actually better in boosted clean secondaries than lithium-6! For 14.1 Mev neutrons from T+D fusion, lithium-7 has a 0.3 barns cross-section, compared to just 0.026 for lithium-6! Plus, it gives ANOTHER neutron UNLIKE lithium-6.

Change in entropy,

$$\Delta S = nC_v ln(T/T_o) + nRln(V/V_o)$$

Hence, for isentropic compression (no change in entropy):

$$\Delta S = 0$$



Therefore:

$$C_v ln(T/T_o) = -Rln(V/V_o)$$

Ripple II (boosted Li6D in Be ablator)

~~SECRET/RESTRICTED DATA~~

Hydrodynamic and Nuclear Experiments (U)

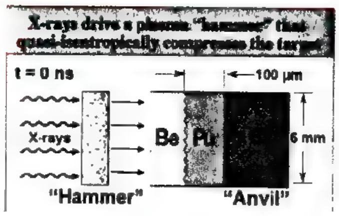
November 2011

JSR-11-340

JSI-2011 027 Copy

Pages 72-3 and Fig 26 on p73 show how "X-rays drive a plasma 'hammer' that quasi-isentropically compresses the target", the target "anvil" being beryllium-coated rippled-interface plutonium

Figure 26:



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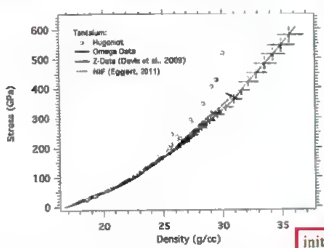


Figure 25: Measurements of the off-Hugoniot Ta EOS

John H. Nuckolls discovered isentropic compression theory for clean thermonuclear weapons from 1957-62 and he successfully tested 99.9% clean 10 megatons Housatonic on 30 October 1962, using 0.3kev x-rays (to avoid radiation wall losses) on a non-pusher (pure ablator)

Ramp = isentropic

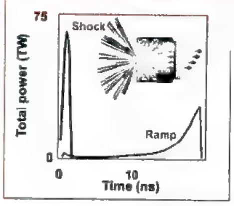


Figure 24: Left: the use of pulse shaping

***Nature*, 15 September 1972**

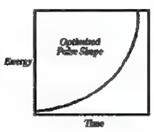
initial shock speed in the imploding matter is comparable to sound speed (pressures of 10^5–10^6 atmospheres) and subsequently so that the compression is near-isentropic;
Optimum x-ray pulse shape needed isentropic Ripple II:

$$\dot{E} = \dot{E}_0 \tau^{-s}$$

where $\tau = 1 - t/t'$, t is time, t' (which is $> t$) is the transit time to the centre of the sphere of the initial shock (generated by application of $\dot{E}_0$), $s = \frac{3\gamma}{\gamma + 1} = 15/8$ for dense hydrogen with degenerate electrons ($\gamma = 5/3$). **(Nuckolls in *Nature*, v239, p139, 1972)**

initially shock compress Pu and then drive it isentropically in a way similar to the environment experienced by a Pu particle in an imploding primary. The concept is shown graphically in Figure 24. Of course, the actual design of the appropriate pulse

encouraging. In Figure 25 we show results from explorations of the Ta EOS on several platforms. The results shown correspond to isentropic compression As can be seen the new NIF data are in good agreement with previous data from the Omega laser and are also in agreement with data obtained on the Z pulsed power platform at SNL The results are the highest pressure off-Hugoniot data achieved to date.



***Pulse shape is* $(1 - t)^{-1.875}$**

Which is produced using plastic foam baffles to control the x-ray transit from the primary stage

Издательский дом «Оружие и технологии»

Оружие и технологии России
Энциклопедия. XXI век

Том 14. Ядерный оружейный комплекс

В книге представлены достижения самой наукоемкой отрасли России – разработка и эксплуатация ядерных боеприпасов, их утилизация, атомная энергетика. Особое внимание уделено ядерной и радиационной безопасности, экологии и безопасности хранения ядерных материалов.

Volume 14. Nuclear Weapons Complex

This volume is dedicated to Russia's most sophisticated industry – development, operation and utilization of nuclear munitions, and nuclear power. Special attention is given to nuclear and radiation safety, ecology and safety of storage of nuclear materials.

Publishing House «Arms and Technologies»

Russia's Arms and Technologies
The XXI Century Encyclopedia

ЯДЕРНЫЙ ОРУЖЕЙНЫЙ КОМПЛЕКС

Энциклопедия XXI век
Оружие и технологии России

NUCLEAR WEAPONS COMPLEX

The XXI Century Encyclopedia
Russia's Arms and Technologies

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DEVELOPMENT OF NUCLEAR MUNITIONS

Хроника основных работ и достижений РФЯЦ-ВНИИЭФ

Milestones of the VNIIEF Efforts and Achievements

1946 – 9 апреля вышло правительственное постановление о создании первого в стране специализированного научно-исследовательского и производственного центра КБ-11 для конструирования и изготовления «реактивных двигателей С» (РДС).

1948–1954 – предложен, разработан и реализован новый принцип нейтронного инициирования ядерных зарядов, что позволило существенно повысить эффективность их действия.

1949 – построена установка ФКБН (физический котел на быстрых нейтронах), на которой были экспериментально определены критические массы плутония-239 и урана-235 для первых атомных зарядов РДС-1 и РДС-2. 29 августа успешно испытана первая советская атомная бомба РДС-1 на Семипалатинском полигоне.

1951 – проведено первое воздушное испытание атомной бомбы с качественно новой системой обеспечения сферического обжатия. Нововведение позволило уменьшить массу изделия по сравнению с РДС-1 и увеличить его мощность более чем в два раза.

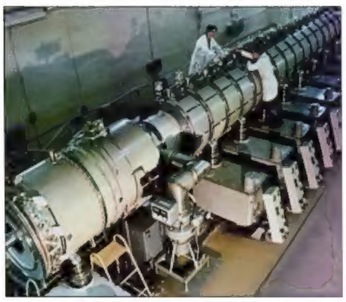
1953 – 12 августа испытан заряд для первой термоядерной транспортабельной авиабомбы.

1955 – 22 ноября испытан термоядерный заряд с принципиально новой физической схемой атомного обжатия.

1957 – обеспечен прорыв в повышении удельных характеристик ядерных зарядов.

1958 – испытан термоядерный заряд с усовершенствованной физической схемой, которая легла в основу развития термоядерного оружия.

1961 – 30 октября испытана водородная бомба мощностью 50 мегатонн на Новоземельском полигоне. Подтверждена возможность создания сверхмощного ядерного оружия.



Линейный индукционный ускоритель электронов ЛИУ-10
The LIU-10 linear induction electron accelerator

1946 – government resolution issued on April 9 to establish the country's first specialized research and production center (KB-11) for design and manufacturing of «jet engines S» (RDS).

1948–1954 – a new concept of nuclear charge neutron initiation proposed, developed and implemented; this enhanced significantly the efficiency of nuclear charges.

1949 – the FKBN facility (Fast-Neutron Physical Boiler) built; it was used for experimental determination of the critical masses of plutonium-239 and uranium-235 for the first nuclear charges RDS-1 and RDS-2. The first Soviet A-bomb (RDS-1) was successfully detonated at the Semipalatinsk Test Site on August 29.

1951 – an A-bomb with a qualitatively new spherical compression system tested in the air for the first time. The innovation made it possible to reduce the item mass as compared to RDS-1 and more than double its power.

1953 – the charge for the first thermonuclear transportable air bomb tested on August 12.

1955 – a thermonuclear charge with an innovative atomic compression physical circuit tested on November 22.

1957 – a breakthrough in improving the specific performance of nuclear charges.

1958 – a thermonuclear charge with an improved physical circuit tested, which laid the basis for the development of thermonuclear weapons.

1961 – an H-bomb of 50 megatons tested at the Novaya Zemlya Test Site on October 30. The feasibility of very high-power nuclear weapons demonstrated.

1962 – the first intercontinental ballistic missile with a VNIIEF-developed thermonuclear warhead adopted for service.

1961–1966 – fundamentals for the development of nuclear charges with as low fission-fragment activity as possible elaborated and grounded experimentally. This laid the basis for the construction of «clean» charges.

1966 – a thermonuclear charge tested on October 27; this demonstrated that it was possible to improve fundamentally its specific performance.

1966–1980 – munitions resistant to casualty effects of nuclear explosions developed for antimissile and air defense systems.

1967–1981 – physico-mathematical models were expanded considerably, physically new problems were resolved and design based on 2-D programs was shifted to.

1970 – the first intercontinental missiles with multiple reentry warheads went into service.

1970–1975 – gas-dynamic experiment procedures and hardware complexes for experimental trials of items as part of full-scale nuclear tests developed. Many of these did not have international analogs.

1971–1975 – compressibility of porous metals (copper, iron, tungsten and some other elements) at terapascal pressures measured.

1970–1980 – generators of ultrahigh magnetic fields with stable characteristics built. Procedures for physical experiments in these fields developed.

Образцы ядерного оружия (экспонаты музея РФЯЦ-ВНИИЭФ)

Specimens of Nuclear Weapons (Exhibits of the VNIIEF Museum)

Первая атомная бомба СССР

Ядерный заряд испытан 29 августа 1949 года на Семипалатинском полигоне. Мощность заряда до 20 кт тротилового эквивалента.

USSR's first A-bomb

The nuclear charge was tested at the Semipalatinsk Test Site on August 29, 1949. Yield: up to 20 kt.

Первая тактическая серийная атомная бомба

Испытана в 1953 году на Семипалатинском полигоне. Мощность заряда до 30 кт тротилового эквивалента. На вооружении с 1954 до 1965 года.

First serial tactical A-bomb

Tested at the Semipalatinsk Test Site in 1953. Yield: up to 30 kt. In service in 1954–1965.

Первая водородная бомба

Ядерный заряд испытан 12 августа 1953 года на Семипалатинском полигоне. Мощность заряда до 400 кт тротилового эквивалента.

First H-bomb

The nuclear charge was tested at the Semipalatinsk Test Site on August 12, 1953. Yield: up to 400 kt.

Первая ядерная боевая часть для тактической ракеты

Мощность заряда до 10 кт тротилового эквивалента. Дальность полета до 32 км. На вооружении с 1960 до 1967 года.

First nuclear warhead for tactical missile

Yield: up to 10 kt. Range: up to 32 km. In service in 1960–1967.

Термоядерный боевой блок для первой межконтинентальной баллистической ракеты с разделяющейся головной частью

Мощность заряда более 2 Мт тротилового эквивалента. Дальность полета до 12 000 км. На вооружении с 1970 до 1979 года.

Thermonuclear combat unit for the first intercontinental ballistic missile with a multiple reentry warhead

Yield: over 2 Mt. Range: up to 12,000 km. In service in 1970–1979.

Первая ядерная боевая часть для баллистической ракеты среднего радиуса действия

Мощность заряда до 40 кт тротилового эквивалента. Дальность полета до 1200 км. На вооружении с 1955 до 1960 года.

First nuclear warhead for medium-range ballistic missile

Yield: up to 40 kt. The range is up to 1,200 km. In service in 1955–1960.

Первая термоядерная боевая часть для межконтинентальной баллистической ракеты

Мощность заряда до 3 Мт тротилового эквивалента. Дальность полета до 8500 км. На вооружении с 1960 до 1966 года.

First thermonuclear warhead for intercontinental ballistic missile

Yield: up to 3 Mt. Range: up to 8,500 km. In service in 1960–1966.

Самая мощная в мире экспериментальная водородная бомба

World's most powerful experimental H-bomb

Испытана 30 октября 1961 года на полигоне «Новая Земля» на половинную мощность. Расчетная мощность более 100 Мт тротилового эквивалента.

Tested to half-yield at the Novaya Zemlya Test Site on October 30, 1961. Estimated yield: over 100 Mt.

Термоядерные боевые части для оперативно-тактических ракет

Thermonuclear warheads for operational tactical missiles

1 – Первая термоядерная боевая часть для оперативно-тактической ракеты.

Мощность заряда до 300 кт тротилового эквивалента. Дальность полета до 900 км. На вооружении с 1965 до 1986 года.

2 – Термоядерная боевая часть для оперативно-тактической ракеты.

Мощность заряда до 200 кт тротилового эквивалента. Дальность полета до 450 км. На вооружении с 1981 до 1991 года. Снята с вооружения по Договору о РСМД.

1 – First thermonuclear warhead for operational tactical missile.

Yield: up to 300 kt. Range: up to 900 km. In service in 1965–1986.

2 – Thermonuclear warhead for operational tactical missile.

Yield: up to 200 kt. Range: up to 450 km. In service in 1981–1991. Decommissioned under the INF Treaty.

Термоядерный боевой блок для ракеты среднего радиуса действия с разделяющейся головной частью

Thermonuclear combat unit for medium-range missile with a multiple reentry warhead

Суммарная мощность заряда до 400 кт тротилового эквивалента. Дальность полета до 5000 км. На вооружении с 1976 до 1991 года. Снята с вооружения по Договору о РСМД.

Total yield: up to 400 kt. Range: up to 5,000 km. In service in 1976–1991. Decommissioned under the INF Treaty.

Общий вид музея РФЯЦ-ВНИИЭФ
The VNIIEF museum. Overall view

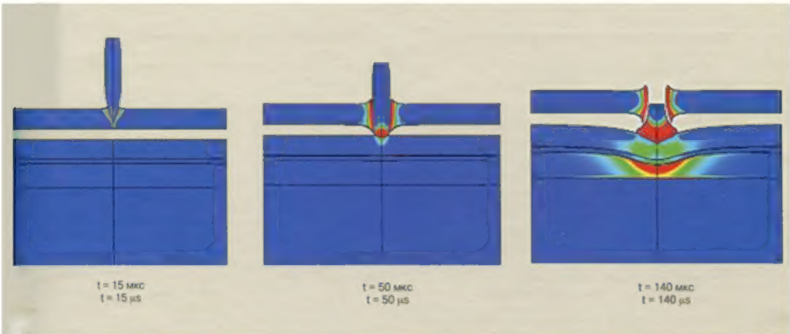
щих необходимую для расчетов информацию о свойствах веществ, отработаны новые технологии проведения расчетно-теоретических работ по основным направлениям деятельности.

Серьезные успехи достигнуты специалистами института в следующих областях:

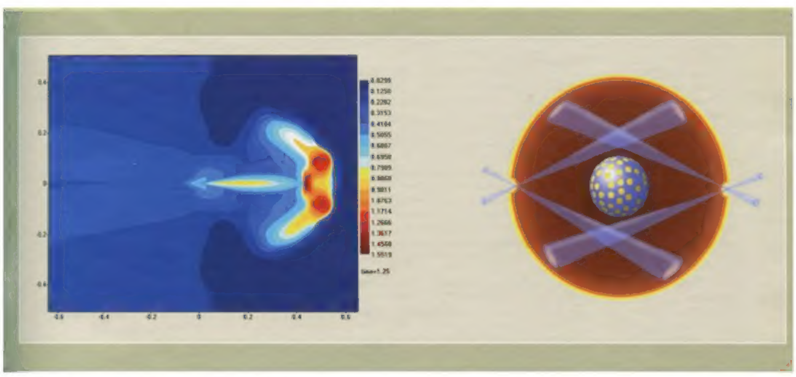
- моделирование на ЭВМ многомерных задач физики ядерного взрыва, лазерной физики в полной замкнутой постановке с одновременным учетом всех ведущих физических процессов;

The VNIIEF specialists have succeeded in the following areas:

- computer-aided simulation of multivariative nuclear explosion and laser physics problems in a complete closed statement with all leading physical processes taken into account;
- studies into characteristics of turbulence; it has been for the first time that results of a range of experimental measurements were interpreted through direct numerical simulation of gravitational turbulent mixing using multiprocessor computers;



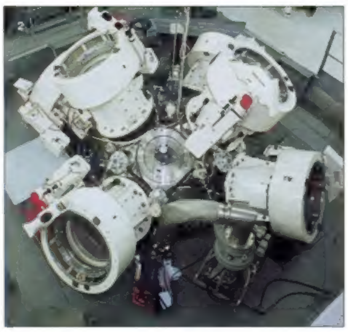
Процесс деформации материала при внешнем воздействии
A material deformation process at external effects



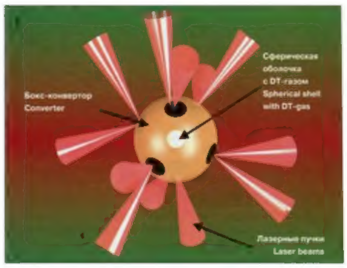
Моделирование процессов термоядерного синтеза
Thermonuclear fusion simulation process

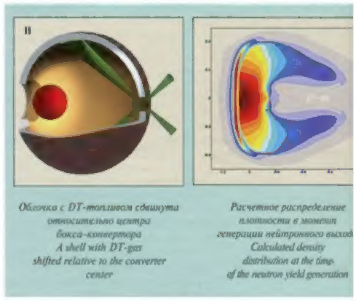
- исследование характеристик турбулентности: впервые путем прямого численного моделирования гравитационного турбулентного перемешивания на многопроцессорных ЭВМ удалось объяснить результаты ряда экспериментальных измерений;

- development of multiprocessor computer systems and up-to-date computer networks;



Здание (1) и сферическая камера взаимодействия (2) установки «Искра-5»
The «Iskra-5» building (1) and spherical interaction chamber (2)





Оболочка с DT-топливом сдвинута относительно центра бокса-конвертора
A shell with DT-gas shifted relative to the converter center

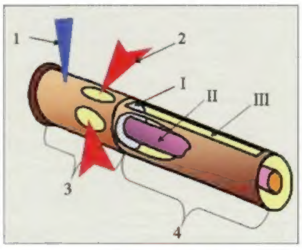
Расчетное распределение плотности в момент генерации нейтронного выхода
Calculated density distribution at the time of the neutron yield generation

Эксперименты по сжатию мишеней в сферических боксах-конверторах в симметричных (I) и ассимметричных (II) условиях
Target compression experiments under symmetrical (I) and asymmetrical (II) conditions in spherical converters

(уровень неоднородности < 3 %) симметрию рентгеновского поля на поверхности сферической микромишени и осуществить уникальные исследования сжатия оболочек с DT-топливом в симметричных условиях. Проведены экспериментальные исследования влияния асимметрии оболочки и рентгеновского поля на эффективность работы термоядерной мишени, результаты которых проанализированы с помощью двумерных программ радиационной газовой динамики, созданных в Институте теоретической и математической физики РФЯЦ-ВНИИЭФ. Получено удовлетворительное согласие результатов экспериментов и расчетов, которое свидетельствует о хорошей точности расчетного описания двумерного течения высокотемпературной плазмы.

На установке «Искра-5» зарегистрирована генерация рентгеновского излучения с длиной волны 10,6 нм на переходе J = 0 – 1 неоноподоб-

tions. Experimental studies into the impacts of the shell and X-ray field asymmetry on efficiency of the thermonuclear target operation have been conducted and the respective findings have been reviewed based on 2-D radiation gas-dynamic programs developed at VNIIEF's Institute for Theoretical and Mathematical Physics. Satisfactory agreement of the experiment and calculation results has been obtained, which evi-



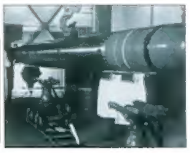
Принципиальная схема мишени для исследования распространения рентгеновского излучения:
I – выходное окно; II – внутренний цилиндр; III – диагностическая щель;
1 – подвес; 2 – лазерные пучки; 3 – корпус «Иллюминатора»; 4 – цилиндрический канал

Schematic diagram of the target for research into the X-ray distribution
I – outlet window, II – inner cylinder, III – diagnostic slit;
1 – suspension, 2 – laser beams, 3 – the «Illuminator» body, 4 – cylindrical channel

Взрыв водородной бомбы РДС-37 22 ноября 1955 года на Семипалатинском полигоне
Explosion of the RDS-37 H-bomb at the Semipalatinsk test site on November 22, 1955

In the morning of September 21, 1955, the USSR's first underwater nuclear explosion was conducted in the Chernaya Bay by detonation of the T-5 torpedo warhead at a depth of 12 m. Its yield was 3.5 kt. Following automatic generation of the signal to detonate the torpedo charge, a vast pillar of water with a crown of a brightly white cloud rose from the sea. One could perfectly see as the water pillar crown evolved, gases broke through it and the base surge curl formed.

Commander-in-Chief of the USSR Navy led and was responsible for the first underwater nuclear test.



71-й полигон ВВС и войсковые учения на Тоцком полигоне с применением атомной бомбы

В 1950–1951 годах шла подготовка к первому испытанию в СССР атомной бомбы РДС-3 со сбросом ее с самолета в режиме боевого бомбометания. Такое первое испытание состоялось 18 октября 1951 года на Семипалатинском полигоне: авиабомба мощностью 42 кт была взорвана над его опытным полем на высоте 380 м. Так впервые в СССР был произведен воздушный ЯВ. И этот результат, по существу, явился основой для принятия решений об оснащении советских ВВС ядерным оружием: было организовано ядерное производство авиабомб РДС-4 и их носителей – самолетов Ту-4.

В государственной системе организации и проведения ЯИ большую роль сыграл 71-й полигон ВВС, расположенный в Крыму (в районе пос. Багерово), который был создан в августе 1947 года. Его личный состав в 1949–1962 годах участвовал в 178 ядерных испытаниях: на СИП – в 94 ЯИ, на СИПНЗ – в 83 и еще в одном – на Тоцком полигоне, в ходе войскового учения с применением атомной бомбы в режиме бомбометания с большой высоты.

На этом полигоне ВВС подвергались также соответствующим испытаниям и самолеты – носители атомных бомб, и самолеты-лаборатории: Ту-16, Ил-28 и Су-7б (на СИП); Ту-16, Ту-35 и 3М (на СИПНЗ); отрабатывался Бе-12, который проходил испытания как носитель противолодочного ядерного оружия без привлечения к натурным ЯИ.

Следует отметить, что результаты исследований воздействия ЯВ привели к выводу о возможности эффективного действия Вооруженных Сил на поле боя в условиях применения противником ядерного оружия. В этом контексте следует рассматривать и войсковые учения, проводившиеся на Тоцком артиллерийском полигоне в Оренбургской области в сентябре 1954 года, в ходе которых был произведен воздушный ЯВ мощностью 40 кт на высоте 350 м. Такая высота подрыва изделия РДС-3 обеспечивала незначительное радиоактивное загрязнение территории в эпицентре взрыва и на следе радиоактивного облака. В ходе этих учений принимали участие около 45 тыс. военнослужащих. Это были единственные в СССР масштабные войсковые учения в условиях натурного ЯВ. Столь уникальным учением руководил Маршал Советского Союза Г.К. Жуков.

Обсуждение решения сторон на войсковых учениях
Discussion of a decision by parties to the military exercise

71st Air Force test range and military exercises at the Totskoye test range in the A-bomb explosion conditions

In 1950-1951, efforts were underway in the Soviet Union to prepare for the country's first test of the atomic bomb (RDS-3) to be dropped from an aircraft under combat bombing conditions. This test was conducted on October 18, 1951 at the Semipalatinsk test site. The 42 kt air bomb was detonated at the altitude of 380 m over the site's proving ground. This was the first Soviet air nuclear explosion. The result of the test was essentially the basis for further decisions to arm the Soviet Air Force with nuclear weapons. This stimulated the opening of the manufacture of RDS-4 nuclear air bombs and their carrier aircraft (Tu-4).

Within the government nuclear test organization and performance system, this was greatly helped by the 71st Air Force test range near Bagerovo, the Crimean Oblast. The range was set up in August 1947 and, in 1949–1962, its personnel were involved in 178 nuclear tests, including 94 tests at Semipalatinsk, 83 tests at Novaya Zemlya and one more test undertaken at the Totskoye range as part a military exercise involving the use of an A-bomb in the high-altitude bombing conditions.

This Air Force test range was also the site for respective tests of nuclear bomb carriers and laboratory aircraft, including Tu-16, Il-28 and Su-7b (at Semipalatinsk), and Tu-16, Tu-35 and 3M (at Novaya Zemlya). These also included tests of the Be-12 aircraft as the carrier of anti-submarine nuclear weapons with no full-scale nuclear explosion involved.

It is worth noting that results of the studies into effects of nuclear explosions led to a conclusion that Armed Forces could act effectively on battlefield after the use of a nuclear weapon by the enemy. This context can be also used to address the military exercises held at the Toskoye artillery range in the Orenburg Oblast in September 1954, when an air nuclear explosion of 40 kt was detonated at the altitude of 350 m. Such altitude of the RDS-4 detonation ensured small radioactive contamination of the territory in the explosion

Заместитель министра обороны СССР Г.К. Жуков и министр среднего машиностроения СССР В.А. Малышев
USSR Deputy Defense Minister G.K. Zhukov and the USSR Minister of Medium Machine-Building V.A. Malyshev

Атомную бомбу сбросил на обозначенную цель на Тоцком полигоне экипаж подполковника В.Я. Кутырчева, который уже имел опыт пяти летных испытаний атомной бомбы на Семипалатинском полигоне. Произошло это 14 сентября 1954 года в 9 ч 34 мин.

В подготовке и в ходе учения приняли активное участие руководство Министерства среднего машиностроения СССР во главе с В.А. Малышевым, а также ведущие ученые – создатели ядерного оружия И.В. Курчатов, К.И. Щелкин и руководство всех родов войск и сил флота, командование всех групп войск, военных округов, округов противовоздушной обороны, флотов и флотилий. На учение были приглашены все министры обороны дружественных в то время нам стран. Войсковое учение под кодом «Снежок» в штабных документах называлось: «Прорыв подготовленной тактической обороны противника с применением атомного оружия».

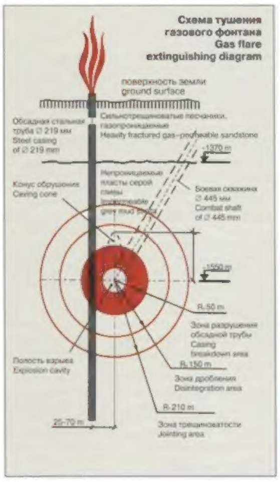
17 сентября ТАСС сообщило: «В соответствии с планом научно-исследовательских и экспериментальных работ в последние дни в Советском Союзе было проведено испытание одного из видов атомного оружия. Целью испытания было изучение действий атомного взрыва. При испытании получены ценные результаты, которые помогут советским ученым и инженерам успешно решить задачи по защите от атомного нападения».

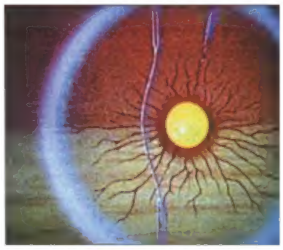
epicenter and in the radioactive cloud pattern. The exercise involved some 45,000 troops and this was the USSR's only large-scale military exercise in conditions of a full-scale nuclear explosion. This unique exercise was commanded by Marshal of the Soviet Union G.K. Zhukov.

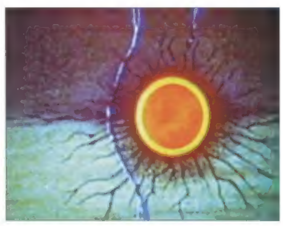
The A-bomb was dropped onto the specified target at the Toskoye range by the crew led by Lieutenant-Colonel V.Ya. Kutyrchev who had an earlier experience of five A-bomb flight tests at the Semipalatinsk test site. The event took place at 9.34 a.m. September 14, 1954.

The work to prepare and conduct the exercise involved the leaders of the Ministry of Medium-Machine Building headed by V.A. Malyshev, leading nuclear weapons scientists including I.V. Kurchatov and K.I. Shchelkin, leaders of all arms and naval forces, and commanders of all groups of troops, military districts, air defense districts, fleets and flotillas. The exercise was attended by all defense ministers of the USSR's friendly countries at the time. Codenamed «Snezhok», it was referred to in staff documents as the «Break through the enemy's prepared tactical defense using nuclear weapons».

A TASS report of September 17 read: «In keeping with the plan of research and experimental work, the Soviet Union has recently conducted a test of one of the nuclear weapon types. The purpose of the test was to study the effects of a nuclear explosion. Valuable results have been obtained during the test that will help Soviet scientists and engineers with successful solution of the task to provide defense against atomic attack».







международным наблюдением и посредством соответствующих международных процедур потенциальные блага от любого мирного применения ядерных взрывов были доступны государствам – участникам настоящего Договора, не обладающих ядерным оружием, на недискриминационной основе, и чтобы стоимость используемых взрывных устройств для таких участников Договора была такой низкой, как только это возможно, и не включала расходы по их исследованию и усовершенствованию...»

Свое практическое воплощение идеи использования подземных ЯВ в народно-хозяйственных целях в Советском Союзе получили, в частности, благодаря инициативе и широкой поддержке со стороны министра среднего машиностроения Е.П. Славского.

В короткие сроки были разработаны и созданы специальные ядерные заряды для МЯВ, которые имели габариты, позволяющие использовать их в скважинах, выдерживали большие давления и температуры и имели заданные проектом уровни энерговыделения. Это определило технические возможности и высокую эффективность применения подземных ЯВ для реализации в СССР многих народно-хозяйственных программ, осуществление которых обычными средствами было малоэффективно. Так в 60-е годы XX века начали разрабатываться основные положения Государственной программы № 7 «Ядерные взрывы для народного хозяйства». Руководителем программы стал заместитель Е.П. Славского профессор А.Д. Захаренков, ее научным руководителем – профессор О.Л. Кедровский.

Работа разворачивалась быстро: уже в 1965 году были проведены четыре эксперимента по программе МЯВ.

broad support from the Minister of Medium Machine-Building Ye.P. Slavsky.

Special nuclear charges for peaceful nuclear explosions were developed and built within a short period of time. These